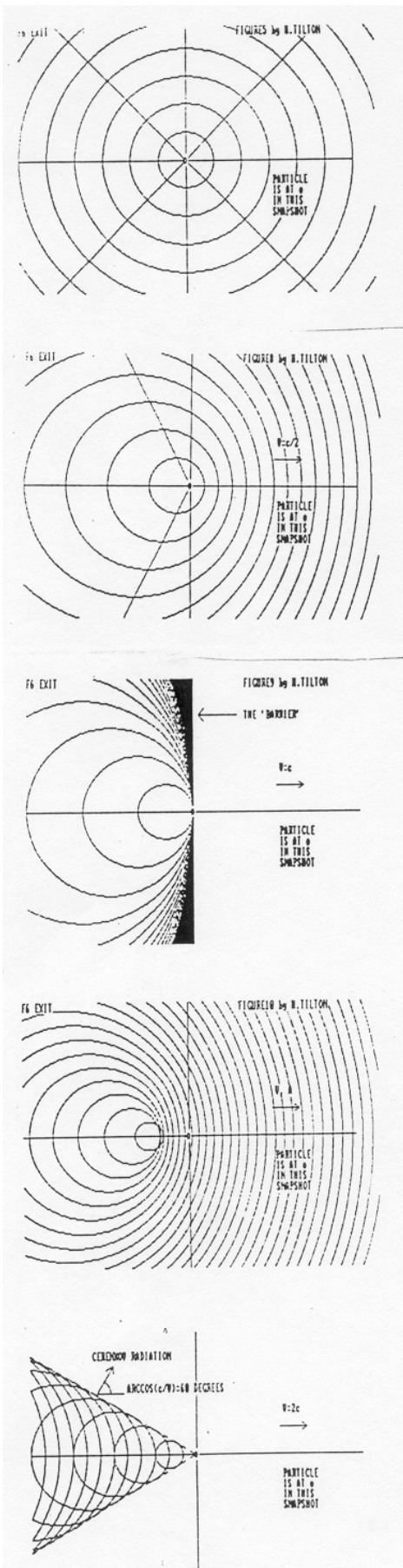


BEGIN the ADVENTURE

How to Break the Light Barrier by A.D. 2070

2nd Edition

Homer B. Tilton
Florentin Smarandache



Pima College Press

BEGIN THE ADVENTURE
How to Break the Light Barrier by A.D. 2070
(Second edition)

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Pima College Press
2005

To the memory of Benjamin E. Tilton (1876-1955), a close contemporary of Albert Einstein (1879-1955).

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Contents

Page

Preface	1
Preface to the 2004 Beta Edition	4
Second Author Preface	6
Guest Preface	7
Acknowledgments	8
About the Cover	9
Isochrons	10
Integrals	11
Chapter 1.....	12
Notes	17
Chapter 2.....	18
Introduction	18
Einstein's conclusion	21
Relativity \neq Light Barrier	22
Einstein's retraction	24
Notes:	27
Interpretation	28
Chapter 3.....	30
Section 1. The second postulate close-up	31
The <i>ad hoc</i> hypotheses.....	36
Section 2. The barrier: absolute, or only conditional?	37
The cable-car model	39
Three new analyses.....	41
Notes	43
Chapter 4.....	45
Analysis	46
Light sailing	47
A sop to the gods.....	48
Notes	48
Appendix 4A	52
Cerenkov electrons.....	57
Appendix 4B.....	58
Chapter 5.....	59

Rocket dynamics.....	60
Project SETI expanded.....	62
The homesick Centaurians	64
H. G. Wells' time machine.....	64
Einstein's time machine	65
What is the truth?	67
Summing up.....	68
Notes	68
Chapter 6.....	72
Venerable force or cognitive illusion?	73
Compounding velocities.....	74
Risky business.....	75
Venerable force or kinematical perspective?	75
The dreams of the young die hard	77
Finally, we find, Einstein changed his mind	78
Notes	82
Chapter 7.....	86
Terminology	86
Introduction	86
The mission	88
Permission to come aboard, sir	89
An academy in space	94
Module arrangement of SS Alpha	96
The mission begins	97
The four-year voyage outward.....	98
Are we there yet?.....	100
San Salvador ho!	101
Heading homeward	101
Welcome home starman!	102
Home and Family	103
Appendix	109
Preliminary plans for SS Alpha	109
Elevation views looking forward (Not to Scale).....	110
Elevation views looking forward.....	110
Shift Assignments	112
Chapter 8.....	113

An extreme ride	114
Born again.....	115
Onward and upward!.....	116
A science experiment.....	117
Epilog.....	119
Glossary.....	119
Appendix 8A	120
Appendix 8B	121
Map of the John McCain Southern Arizona Starport	
Corridor	122
Chapter 9.....	123
Notes	125
Appendix 9	126
Megalopolitan exobiology	126
Humanoid vision.....	127
Do the Megalopolitans see in color?	127
Notes continued	129
Chapter 10.....	131
Introduction	131
Scientific Hypothesis	132
An Open Question now	132
Controversies	132
Future possible research.....	133
Notes	133
About the Authors.....	137

Preface

For this edition, new material includes:

- (1) Expansion of the cover illustration to depict two more cases of particle motion (total of five);
- (2) An additional guest preface from Mendel Sachs was declined. NB: An overture was made to Don Lincoln of Fermilab to include one of his e-mailings as still another guest preface. He declined. Even so we reserve the right of fair use, just as with any author or correspondent, of his writings here and there wherever we feel the reader will find helpful either to support or to contrast with the main text.
- (3) New mathematical material at the end of this front matter for use in conjunction with the front cover illustration;
- (4) New material at Ch.2 and 3;
- (5) New material at Ch.7: a conversation on the twin paradox; plans for Starship Alpha;
- (6) New material at Ch.9, description of the Megalopolitans.

At the time the first edition was written the first author was unaware of Einstein's little 1922 book, *Sidelights on Relativity* in which he "changed his mind" as Mendel Sachs put it. In that book (a Dover reprint is available with ISBN 0-486-24511-X) Einstein revokes his initial view, which led to his declaration of a light barrier and the twin paradox, on pages 35 & 36, where he writes "*Sub specie aeterni* Poincare, in my [present] opinion is [was] right." Recall that both Poincare and Lorentz thought of the effects of special relativity as appearances only.

That change of mind of Einstein's certainly lends credence to the arguments presented in the first edition and this one.

Because of the almost universal failure to recognize the distinction between *physical* (reality-based, dynamical) and *visual* (appearance-based, kinematical) variables, a tremendous volume of contemporary mythology arose over the past 100 years around Einstein's *reality view* of the distortions of special relativity. To get a sense of it, we point the reader to Paul J. Nahin's heroic book, *Time Machines*, 2nd ed.- to these

Tech Notes in particular: **TN#6** “A High-Speed Rocket is a One-Way Time Machine to the Future”; **TN#7** “Superluminal Speeds, Backward Time Travel, and Warp Drive, or Faster-Than-Light into the Past”; **TN#8**. “Backward Time Travel According to Gödel and Tipler.” But those magical effects go away when we consider that the variables of special relativity are kinematical, not physical. If they have not yet gone away in the minds of everyone, a reason may be that there is a great need felt by many fine folk for such effects to be real.

There are today sizeable popular and scientific communities with vested interests in keeping those magical hopes alive. But at some point in time humanity must come of age, question the existence of Santa Claus and come to realize that what we see is not necessarily what we get. ...That the stick partly stuck in water may not be bent or broken after all even though it distinctly and definitely appears to be. Distinguished cognitive researcher Massimo Piattelli-Palmarini might characterize the period just ending as a century-long “mistake of reason” - a kind of *mass cognitive illusion*. MP-P, *Inevitable Illusions/ How Mistakes of Reason Rule Our Minds*, John Wiley, ISBN 0-471-58126-7, 1994, p.18: “These are errors we commit without knowing that we do so, in good faith, and errors that we often defend with vehemence, thus making our power of reasoning subservient to our illusions.” Page 141: “Cognitive illusions, unknown to science until some 20 years ago, are active in all of us...” Page 139: “Cognitive illusions are general, because they are found in all human beings...” MP-P did not direct his message at Einstein; that is my doing. I did not find Einstein’s name mentioned anywhere in the book; and the one mention found of a derivative of “relativity,” namely “relativists” (p.4), used the word in a different sense, in reference to *relativism*, a theory of knowledge. Yet the descriptions MP-P gives seem to fit the present context.

Certainly there are barriers; accelerated particles in a particle accelerator encounter one, and the proposed light-pressure sailing starship would certainly encounter one also. It is easy to show, by logical analysis under relativity that those two instances of a light barrier hold; but it would be silly to teach that the light barrier is *an absolute cosmic truth* and that that’s all you need to know about it. It is encouraging to find that more and more scientists are coming to recognize the importance of

the distinction between physical variables and kinematical ones in this connection. And the final twist is that even Einstein came to change his mind about this in 1921.

Our purpose in going to the stars need not depend entirely on the likelihood of there being other intelligent life in the universe that uses technology; we must also plan for the persistence of humanity even past the life of our planet and the life of our sun. The way to do that is to continue to spread our seed throughout the universe - not in a helter-skelter way, but in a controlled, planned, intelligent way. And while we're working towards that goal, it would be a shame to miss out on the richness of the adventure by putting it off and putting it off.

Consider this *gedanken Gespräch* (thought conversation); the participants: Einstein, age 30, and Poincaré, age 55; date: Monday 19 April 1909; place: Berne, Switzerland:

Einstein: Happy birthday Jules. Let's talk relativity.

Poincaré: Thank you Albert. What do you want to talk about?

Einstein: I just want to say that what you see is what you get.

Poincaré: Nonsense. What you see is only what you see. You may or may not "get" it.

That *gedanken Gespräch* sets the tone for this book.

This book is not an attempt to repudiate relativity; rather it attempts to clarify it. The book outlines an experimental design to test that clarification. It suggests that perhaps the only thing wrong with relativity is its usual interpretation. The Grand Experiment, in its two phases, is not a thought experiment; instead, it is an outline for a proposed real experiment. No conclusion concerning relativity is drawn from it. Ch.7 (Phase 1), Ch.8 (Phase 2) and Ch.9 are strictly fiction.

From Ch.7: "In any case there'll be no attempt to exceed lightspeed this time out. The prevailing view remains that it cannot be done, and until convincing evidence to the contrary is found, it is probable that no attempt will be made to do it." Chapters 8 & 9, still fiction, rest on a change in that mindset.

Homer B.Tilton/Tucson, Arizona
Oct. 2004; rev.Sept.2005

Preface to the 2004 Beta Edition

For most of the 20th century, both relativity and star travel fascinated this writer. The reasons Albert Einstein concluded there is an absolute barrier at the speed of light seemed at first clear, then later not so clear upon closer examination.

“The speed of light relative to what?” I would ask anyone who would listen. The common response was, “Light needs no specification of that kind; its speed is the same no matter who measures it.”

“That’s true.” I would respond; “That’s just the second postulate of special relativity which is not in doubt; but that postulate applies to *light*, and we’re talking about rocketships here.” However it seemed that no one understood what I was saying.

By referring to the universal constant $c = 299.792\,458$ megameters per second as “the speed of light,” we paint ourselves into a logical corner in which *light* is automatically taken as the subject of discussion even when it is not. The careful reader will know not to immediately think “light” when he hears or reads “the speed of light.” But it is better to have a neutral name for that universal constant. It has been called *the Lorentz speed*; Ignazio Ciufolini & John Archibald Wheeler (1995) called it *the characteristic speed of space*, and they were then able to apply it to all “primordial forces” whether electromagnetic or gravitational or other (what other, C&W did not say).

A fundamental difficulty that even experts have is separating Einstein’s conclusion of a light barrier from the postulates of relativity. His conclusion does not follow directly from those postulates. One can accept the postulates and still justifiably doubt the impenetrability of the barrier. If one ferrets out the reasons for the *penetrability* of the local light barrier in the moderating baths of nuclear reactors by high-energy electrons then one can begin to see what is involved.

To help us do that, an appendix to chapter 4 explores an analogy wherein a case is made for calling c the *resonant speed of space*. For the engineer and the radio amateur, the term “resonance” can lead to a whole new vista of mental images, a healthy vista in the present context. To

radio amateurs and those other readers who are knowledgeable in such matters I say, go now; go where your instincts take you.

The premise of this book is that the effects of the special theory of relativity are a kinematical perspective rather than being real; but “reality” is a slippery concept, and it is expected that the reader will keep that in mind. Towards clarifying that concept insofar as it applies herein, a working definition will unfold as the reader progresses through the book. The test of reality to be ultimately applied is whether or not it is *really* impossible to make a round trip to Alpha Centauri in a reasonable time.

This book, *BEGIN THE ADVENTURE*, 2004, is the latest in a trilogy starting with *THE LIGHT BARRIER*, 1990, and continuing with *LIGHT BEYOND BELIEF*, 1995. Contact me for copies of those prior books. Related analyses from this writer also appear in *Speculations in Science and Technology*, 1993 (ISSN 0155-7785); and in *Electron and Ion Beam Science and Technology* from The Electrochemical Society, 1968.

Homer B. Tilton
April 2004; rev. Sept.2005

Adjunct Professor of Mathematics
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Second Author Preface

The hypothesis is presented in Chapter 10 that there is no speed barrier in the universe and that one can construct arbitrary speeds. One then asks if it is possible to have an infinite speed. The basis for the hypothesis lies in the entanglement theory of quantum mechanics and deals with the transfer of information over large distances.

Dr. Florentin Smarandache
February 2004

Professor of Mathematics
The University of New Mexico at Gallup

Guest Preface

Akhlesh Lakhtakia

The special theory of relativity (STR) is indeed a kinematical perspective. By that I mean to say that STR simply deals with velocities, which are kinematical quantities. That the speed of light is the same for all inertial reference frames is seen from experiment. Being a theorist, I cannot undertake a real experiment; however, the *Grand Experiment* that Homer proposes is only a thought experiment and I support his right to consider it.

Insofar as “reality” is concerned I claim not to know it. I only accept that all is illusion, and that “reality” is whatever one chooses to accept. Hence, I cannot state that STR is “reality”; but then I cannot also state what exactly is “reality.” I am, however confident that much of my research on thin films and other complex materials is performed under the rubric of STR, my ignorance of “reality” notwithstanding.

Dr. Akhlesh Lakhtakia
March 2004; rev. Sept.2004

Distinguished Professor,
Engineering Science and Mechanics
Distinguished Professor,
Graduate Program in Materials
Pennsylvania State University

Ed. Note: *The Grand Experiment, rather than being a thought experiment, is written as fiction (Ch.7, Phase 1, and Ch.8, Phase 2) and is presented as the outline of an actual proposed experiment. ...HBT*

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The following individuals are acknowledged:

For stimulating, enlightening exchanges:

Dr. Mendel Sachs, physicist/astronomer State U. of NY at Buffalo
Don Lincoln, Research Physicist, Fermilab

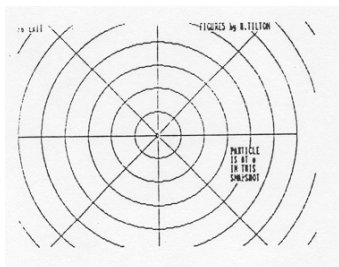
And for helpful discussions:

Dr. David Iadevaia, PCC-EC, astronomer
Jim Malmberg, PCC-EC, engineer
John Oliver, PCC-EC, engineer
Nigel Sharp, physicist

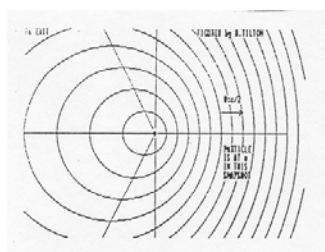
Also, many thanks to Dr. John Weaver for many stimulating discussions on this and other subjects while we were together in undergraduate school, MSU, 1947-50. ...HBT

About the Cover

The five illustrations on the cover show the pattern of isochrons for different states of motion in a series of snapshots. The interstellar medium may be taken to be at rest relative to the observer.



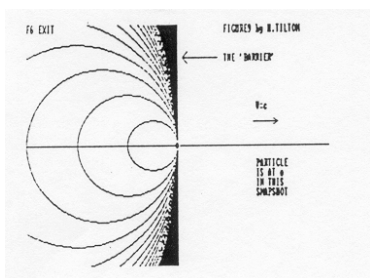
Top - Body at rest relative to the observer. The pattern is that of classic equipotential surfaces, concentric spheres centered on the particle.



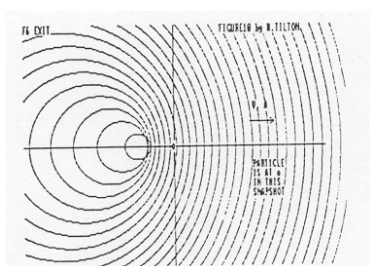
Next - Body which has been moving to the right at a constant speed less than the speed of light for a long time. The average density of isochrons over all space is increased over the zero-speed density by the relativistic factor, $1/\sqrt{1-\beta^2}$,

$$\frac{1}{\pi} \int_0^\pi \frac{d\theta}{1-\beta \cos \theta}$$

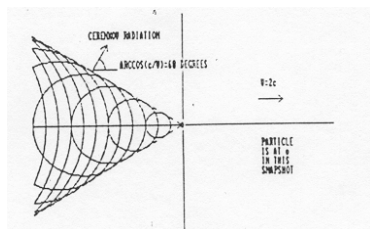
obtained as



Center - The pattern of isochrons from a rocket which has been moving at the speed of light for a long time. The barrier is evident. The average density of isochrons is infinite.



Next - The pattern as the rocket accelerates through the speed of light with an acceleration which has been constant for a long time. Note that there is no longer a barrier in evidence.



Bottom - The pattern corresponding to a rocket which has been moving at twice the speed of light for a long time. The Cerenkov shockwavefront is clearly shown. The average algebraic density of isochrons over all space is zero, obtained again as

$$\frac{1}{\pi} \int_0^\pi \frac{d\theta}{1-\beta \cos \theta}$$

Isochrons -

By “a long time” is meant a time long enough so that transient effects have died out; long enough so that only the specified speed or acceleration parameter has a significant affect on the pattern.

Isochrons are the loci of gravitational or electrical quanta which are emitted from the particle at the same time. Even though quanta are emitted uniformly in a continuous stream with density proportional to the *strength of the source* (e.g., the “rest mass”), the depictions are of isochrons corresponding to discrete, regular, successive times of emission, as if a strobe light were being used for illumination. Isochrons are spherical bubbles of information expanding at the speed of light with center at the position the particle had at the time of emission in the observer frame, as required by the second postulate of special relativity.

The analysis for the case of constant sublight speed (second illustration) is detailed in the international journal *Speculations in Science and Technology*, Vol.16, No.4, 1993, ISSN 0155-7785, pp. 297-303.

Integrals -

From the *CRC Handbook of Chemistry & Physics*, #341; or from Gradshteyn & Ryzhik, 2.553-3; or from Schaum's, #14.390:

$$\int_0^\pi \frac{dx}{1 - \beta \cos x} = \frac{2}{\sqrt{1-\beta^2}} \arctan \frac{\sqrt{1-\beta^2} \tan x/2}{1-\beta} \Big|_0^\pi, \text{ for } \beta^2 < 1;$$

$$= \frac{1}{\sqrt{\beta^2-1}} \operatorname{Ln} \left| \frac{\sqrt{\beta^2-1} \tan x/2 + 1 - \beta}{\sqrt{\beta^2-1} \tan x/2 - 1 + \beta} \right| \Big|_0^\pi, \text{ for } \beta^2 > 1.$$

For $\beta^2 < 1$, that evaluates to

$$\frac{2}{\sqrt{1-\beta^2}} \left[\arctan \frac{\sqrt{1-\beta^2} \tan \pi/2}{1-\beta} - \arctan \frac{\sqrt{1-\beta^2} \tan 0}{1-\beta} \right]$$

$$= \frac{2}{\sqrt{1-\beta^2}} \arctan \frac{\sqrt{1-\beta^2} \tan \pi/2}{1-\beta} = \frac{2}{\sqrt{1-\beta^2}} \arctan(\tan \pi/2)$$

$$= \frac{\pi}{\sqrt{1-\beta^2}}, \text{ QED\#1;}$$

and for $\beta^2 > 1$, it evaluates to

$$\frac{1}{\sqrt{\beta^2-1}} \left[\operatorname{Ln} \left| \frac{\sqrt{\beta^2-1} \tan \pi/2 + 1 - \beta}{\sqrt{\beta^2-1} \tan \pi/2 - 1 + \beta} \right| - \operatorname{Ln} \left| \frac{\sqrt{\beta^2-1} \tan 0 + 1 - \beta}{\sqrt{\beta^2-1} \tan 0 - 1 + \beta} \right| \right]$$

$$= \frac{1}{\sqrt{\beta^2-1}} \left[\operatorname{Ln} 1 - \operatorname{Ln} |-1| \right] = 0, \text{ QED\#2.}$$

Chapter 1

The Light Barrier

The academic view: *It is indeed known that the special theory of relativity does not necessarily prove the speed of light cannot be exceeded. [RP, Rosser]*

The popular view: *The speed of light in a vacuum is the fastest that anything in the universe can travel. [JM, Z&Z]*

The line between fact and faith is often blurred. In that spirit we ask that the reader please set to one side any pre-knowledge concerning the light barrier while we explore it in these pages.

One's reach should always exceed one's grasp. Thus we reach for Alpha Centauri with a round-trip manned and womanned mission as the proposed overarching goal under a clear plan of exploration - *a Grand Experiment* described in later chapters.

Whether or not we succeed in grasping the goal under this or under any plan is not as important as it is to develop the best plan we can and work towards that goal. The plan outlined here is in two phases: Phase one has a high probability of success, given the required propulsion system; the chances of phase two working will be indicated by results obtained from phase one.

A fundamental problem is the one of propulsion. It is important to the working of this plan, a highly optimistic one, that the engine be capable of a sustained acceleration of $\frac{1}{4}G$ in phase one and $1G$ in phase two. ($1G = 9.80665 \text{ m/s}^2$) Such an engine is within the reach of present ideas.

Aircraft propulsion started with propellers in the Wright Flyer, briefly flirted with rockets in the Bell X1, and has finally settled on air-breathing jets. Taking a lesson from that progression, we propose that the development be accelerated of something along the lines of the

interstellar ramjet proposed by Robert Bussard in 1960. His engine would harvest, en route, the tenuous interstellar cloud material to use as the working fluid or fuel in a nuclear-powered jet engine having a huge, electromagnetically-augmented intake maw. [Since, in our “koino-matter universe,” (Hannes Alfvén, *Worlds-Antiworlds*) atomic nuclei are positive, we might plan to work exclusively with positive ions.] Mallove and Matloff, page 109:[1]

Bussard...found that for a starship mass of 1000 tons ... the craft could accelerate almost indefinitely at one g!

Bussard put the velocity at which the ramjet “bites” (its minimum operational velocity) at a few tens of kilometers per second. (30 km/s is 0.01% c.) But our present concerns are with relativity, not starship propulsion; so we leave it there and bank our propulsion hopes on Bussard and others.

An eight-year manned mission is planned to place a spacebuoy $\frac{1}{4}$ - way to Alpha Centauri at *San Salvador Station* and return to Earth in phase one of the experiment. While such a mission might be carried out with an unmanned probe, the overall purpose of the Grand Experiment, phase one plus phase two, is to transport Humans to another star and return them safely to Earth in a reasonable time. The projected timetable under phase one of the grand experiment is this:

- 2022 - First Human sets boot on Mars;
- 2023 - Development begins of Bussard interstellar ramjet and SS Alpha
- 2037 - Final crew training for SS Alpha begins
- 2040 - SS Alpha commissioned
- 2041 - SS Alpha heads outward at a steady $\frac{1}{4}G$ acceleration; with 12 souls on board;
- 2045 - Spacebuoy placed at San Salvador Station $\frac{1}{4}$ -way to Alpha Centauri;
- 2046 - *Jupiter Station* established;
- 2049 - SS Alpha arrives back at Jupiter Station with all hands safely on-board.

One reason for sending Humans on SS Alpha is to develop a practical biosphere for the phase two round trip to Alpha Centauri. Another reason is to test for psychological, physiological and physical effects of the relativistic distortions. Ever since the introduction of the automobile, speed in transportation has been a concern:

The human factor may prove to be the real limitation [to high speeds]. The human body is ill-adapted to the physical and psychological effects of supersonic flight.

That, from a 1957 encyclopedia (Collier's). But the overarching reason is to properly prepare for the phase-two experiment.

Recent trends in thinking view the distortions of the special theory of relativity as only appearances, unable to affect Human physiology or the intrinsic dimensions of objects. Indeed, it appears that Einstein himself finally came to that view in 1921. While particles in a particle accelerator really are limited to the speed of light, it is easy to show that is because the motor - comprised of the accelerating coils and electrodes - is fixed to the laboratory. The same is true for proposed ships propelled by light pressure from the sun. The sun is the ship's motor and its speed reference. But what about Einstein's sweeping generalization: "From this...we conclude that...[c] can neither be reached nor exceeded"?

In the case of a rocket or jet where the motor travels with the ship, how and why such vessels should be limited to light-speed relative to an Earth-bound laboratory or to the sun or to *anything* remains a mystery. The first manned starship under phase one of the grand experiment - while itself not attempting to exceed lightspeed - would help to resolve that mystery.

The slowing of certain kinds of clocks under increased gravitation and acceleration fields, as predicted by the general theory of relativity, is no doubt real in the sense that the speed of light is slowed in such fields; but note that a pendulum-regulated clock would run *faster* under increased gravity; and the assumption that "time itself" would run slower seems to be a too-sweeping generalization. Physics books tell us that

time has physical meaning only in its measurement in the form of uniformly repeated or periodic motion.

In any event, if a 1G acceleration is maintained throughout the trip to Alpha Centauri under phase two of the grand experiment, then under general relativity all clocks on the ship would be expected to keep pace with those on Earth; and if the twin paradox - formulated under the special theory of relativity - is only an appearance, there would be no permanent “set” in time. Just as a stick removed from water “unbends,” so too would the twin’s age differential apparently suffered under special relativity be expected to “unset itself” when ‘he returns to Earth.

A Human trip to San Salvador Station under phase one of the Grand Experiment, would conclusively test those things. Newton, as popularly paraphrased: “The proof of the pudding is in the eating.” (or, as Prince Charles has said, “The proof is in the pudding.” – 60 minutes, CBS, 30 Oct. ‘05.

Beyond the relativistic distortions, the inability to exceed light speed by compounding velocities is often taken as proof of an absolute barrier at the speed of light. But the resemblance of that scenario to Zeno’s puzzle “The Achilles” is inescapable; and the compounding of velocities is only one particular way that the speed of light cannot be exceeded.

In Zeno’s puzzle, Achilles’ attempt to overtake the tortoise consists of an infinite series of jumps, each cutting in half the remaining distance to the tortoise, with each jump consuming the same amount of time; but that is equivalent to Achilles first running, then walking, then slowing to a crawl as he approaches the tortoise. To a disinterested onlooker it would appear as if Achilles’ goal was simply to pace the tortoise. In a similar way, the speed of light cannot be exceeded by reducing the acceleration towards zero as the goal is approached as is the case with particle accelerators. Is it mankind’s goal to simply *pace photon energy*? A disinterested onlooker might think so under such a circumstance.

Another reason some have given to conclude that c is an absolute speed limit (...Not sure what that means anymore?) is that no energy from a light signal would be returned to us from a body receding faster than that. But in the end, it all comes down to a matter of whether or not the observed distortions reflect actual physical changes to the bodies being

observed. Phase one of the Grand Experiment would help to settle that question in the minds of all.

Recent work with the entanglement theory under quantum mechanics also casts doubt on the impenetrability of the light barrier. Finally, super-fast electrons in the moderating baths of nuclear reactors which produce blue Cerenkov radiation clearly have broken the local light barrier, and it is hard to rationalize the existence of a second barrier there at the free-space speed of light. [2]

The placement of a spacebuoy would be an invaluable experiment in itself. If it indicated that the speed of light is a barrier even for a self-powered rocket, then that would end our aspirations of practical star travel for now. On the other hand if it were to indicate that the relativistic effects are only appearances and that lightspeed presents no physical barrier, then that would mean speeds in excess of 300 megameters per second away from Earth can probably be attained using a rocket or Bussard interstellar ramjet in a way pretty much as Newton might have envisioned. In such an event the projected timetable would continue under phase two of the grand experiment as follows:

- 2049 - Starship Suzue is abuilding;
- 2050 - Crew training for the Alpha Centauri mission begins;
- 2069 - Starship Suzue leaves Jupiter Station for Alpha Centauri at a steady 1G acceleration with four crew and four ambassadors *pro tem*.on-board;
- 2070 - Humans break the light barrier;
- 2073 - Humans reach Alpha Centauri, place two orbiting embassies there in a made-for-TV ceremony;
- 2077 - Starship Suzue arrives back at Jupiter Station with all hands safely on-board.

Notes -

[1] Mallove and Matloff give a good overview of these propulsion methods in Ch.7 & 8 of their book, *The Starflight Handbook*, 1989, ISBN 0-471-61912-4.

[2] The electrical “Q” and the resonance peak (the light barrier) for water are not infinitely high because water is a glossy medium; therefore impinging high-energy electrons are able to cross the barrier. The Cerenkov shockwave can be diagrammed as a series of eccentric circles to accurately show the orientation of the Cerenkov shockwavefront at an angle of $\text{Arccos}(c/(nv))$ to the particle path in a medium whose index of refraction is n . See cover illustration or a physics text.

Chapter 2

The Human Barrier Einstein's Challenge

There is a Human barrier standing guard over the light barrier. It is a buffer that refuses to let rational Human beings question a statement by authority.

Once a barrier is erected and becomes established, it is difficult to dismantle when it becomes no longer useful. The Berlin Wall is an example; the light barrier is another. "The Ocean Sea cannot be crossed" was a popular saying which stood until Columbus performed his own "grand experiment."

Introduction

When we speak of measuring the velocity of a ship and its other parameters as it approaches the velocity of light, a fact commonly overlooked is that when the ship tickles the speed of light, the observer on the Earth loses sight of it anyway; and even relativistic mathematics is unable to penetrate beyond that point. The application of sublight relativistic mathematics beyond that speed is simply inappropriate and can be misleading. Saying that the mass, length and time become imaginary there is without meaning.

It is true that for a ship receding at nearly the speed of light from an observer on the Earth, photons from the ship continue to impinge upon that observer at the speed of light in accordance with the second postulate; but those photons have lost all sensible energy. They have without question become unreal and without practical, physical existence.

In the absence of a convincing argument to the contrary, too many still believe in an absolute light barrier. Even with those who do not, the

thinking is unnecessarily restricted, one subject noting that he is “comfortable” considering the speed of light to be the maximum speed; another noting only that inconsequential phase velocities are known to exceed light speed. Arguments presented in this book are designed to convince even the most diehard skeptic that the theory of relativity does not equate to an absolute light barrier. The theory of relativity is taken as a given throughout the entire book.

Some views are given next. Note closely the variations in views. The first two alone illustrate the extreme opposing views on the subject.

(1) Professor of physics NS at PCC (subsequently with the National Optical Astronomical Observatory, Tucson; then as of Jan ‘05 with the National Science Foundation in Washington, DC): Light as a limit was not Einstein’s opinion; it’s as supported as gravity... Perhaps you should consult with a physicist... (May ‘96)

[We had previously consulted with a physicist. His reaction is noted next. ...HBT]

(2) Professor of physics RP at UA, Dept. Head (“Doctor Parameter”): It is indeed known that the special theory does not necessarily prove the speed of light cannot be exceeded [but] I’m comfortable considering the speed of light to be the maximum speed. As it happens that we have never been able to observe meaningful speed greater than that of light, and because light appears to have the same speed in all inertial frames, physicists take the “maximum speed” to be the speed of light. (Ca. 1972, in a private communication.)

[A view not often seen expressed, and one not substantially different from our own. Apparently RP saw no theoretical basis for ruling out faster-than-light speeds. It might be pointed out that we have never seen a supersonic bird either, and so the fact of non-observance does not seem to be quite adequate to rule out superlight speeds. (“Doctor Parameter” was my doctoral program advisor.) ...HBT]

(3) Professor of astronomy DI at PCC: If an experiment is performed such that “the motor travels with the ship” the KE [kinetic energy] for a given mass “ship” at a given velocity will increase if

relativity is correct or [will not] if Tilton is correct... . The KE will be dependent only on the v^2 and not on the relativistic mass (m) for Tilton to be correct. (March'04)

["Tilton's relativity" is no different from Einstein's relativity except Tilton does not subscribe to Einstein's reality view, in which exception he is not alone. Later conversations with DI were productive. ...HBT]

(4) Professor of engineering JM at PCC: The assertion has been made that if a rocket simply accelerates long enough it will exceed the velocity of light. / To see if this is true one needs to solve for the equations of motion. / The fastest the rocket can go, as measured in the fixed frame, is one light year per year. / The limiting velocity of material objects is the speed of light. / The argument has been made that the mathematics are correct, but that the "apparent" velocities are just an illusion like the apparent bending of a straight stick extending into a pool of water. This is false. The predictions of relativity are real and have been experimentally verified. *Verification of the composition-of-velocities formula near the speed of light is also provided by particle accelerators which accelerate particles near, but never beyond the velocity of light.* Time dilation has been verified by measuring the lifetimes of unstable particles in cosmic ray debris and particle accelerator experiments. Experiment is the final arbiter in science, and experiment verifies that the velocity of light is the speed limit. (Apr'04)

[JM makes some highly argumentative statements of the "everybody knows" kind. The most egregious are underlined. *Script type* marks a disconnected argument. JM's reference to "the equations of motion" apparently is a reference to the composition of velocities formula. Those equations do hold, and particles in particle accelerators are limited to lightspeed, but the two situations are different and are not directly linked.

There are two kinds of time dilation which are almost never separated in these arguments: that due to relative velocity under the special theory, and that due to increased acceleration /gravitation under the general theory. The first is only apparent under the kinematical view, the second - the kind that has been experimentally verified - is no doubt

real in the context of atomic processes. The general-relativity kind of time dilation cannot, however, be used to support a conclusion of special relativity. ...HBT]

(5) Professor of mathematics GH at PCC: But isn't the light barrier an intrinsic part of the axioms (the postulates)? (Aug'04)

Lightspeed may have seemed more than "fast enough" at one time. As Doctor Parameter noted, "I'm comfortable considering the speed of light to be the maximum speed." But now we see that too many consider that view not as simply a comfort, but as a fact. Thus we have such depressing statements as "If standard rockets are used [we will be limited] to a small fraction of light speed." (Robert L. Forward). Not all of us are comfortable with lightspeed being declared the maximum for our ships. Such a stand is questionable; and it would seem to put the stars well out of reach.

Disagreements aside - some saying there is a light barrier some that there is not and still others saying they don't care - that they don't need to go any faster, Einstein presented the distortions described by special relativity as reflecting actual physical changes in the bodies being observed in spite of this elephant-in-the-living-room kind of situation: *The amount of the distortion of any given kind depends on the observer motion*, and so it is different for every observer moving differently; i.e., *it lacks consistency*, just as does the view of a stick partly immersed in water, where the amount of bending depends on where the observer stands. Margenau (p. 292): "The tree is real because ...it satisfies the demands of consistency." The relativistic distortions do not satisfy those demands. They cannot be real. Einstein later came to admit as much.

Einstein's conclusion -

Einstein's reality view would have made little difference if it had not led him and his disciples to conclude that there is an impenetrable barrier at the speed of light: "The velocity c ...can neither be reached nor exceeded by any real body [because, at the velocity of light, objects *really do* shrink to zero length and grow to infinite mass, and time *really does* slow to nothing]." And that appears to have been his reasoning.

Unfortunately almost everyone picked up on that reality theme, and ever since it has been principally those outside the mainstream who openly question that view and the impenetrability of the light barrier. ...Except that initially, when Einstein's interpretations of relativity began filtering out, there was considerable opposition, coming even from such authoritative sources as Lorentz and Poincaré. However, Einstein and others managed to put the questioning down - to suppress it.

For some interesting back-pedaling which has escaped nearly everyone's attention, the reader is referred to Einstein's little-known 1922 book, *Sidelights on Relativity*. [1]

Relativity \neq Light Barrier

A large group seems to equate the theory of relativity with an absolute light barrier; they erroneously think you can't have one without the other.

Einstein's conclusion has come to be seen by many as being part of the second postulate (it is not); and it has remained so firmly ingrained in today's culture that books are written for the general reader which treat it as gospel; one recent book written by Zimmerman & Zimmerman comes to mind.[2] Actually, only the tenth chapter, "Can Anything Travel Faster than Light?" on pages 79-84, deals directly with the light barrier. After asking the question twice more on pages 79 & 80, Z&Z give Einstein's answer at the top of page 81: "The answer is no." Then they present perhaps their strongest argument in support of that answer at the bottom of page 81: "At the speed of light, all the energy that one puts into an object is converted into mass." [3]

Z&Z continue: "A golf ball that is traveling at the speed of light cannot speed up any more." Certainly true in the sense that further accelerating force cannot reach it from the ground.

Z&Z end the chapter on page 84 with: "In media such as glass or water, yes [you can go faster than the local speed of light]" - a point they must grant since Pavel Cerenkov showed it in 1939 to be so after having hypothesized it in 1934 - but they do not address the question of how much faster, except to subsequently write: "The speed of light in a vacuum... is the fastest that anything in the universe can travel." A bald-faced declaration with no traceability to a conclusive proof or a definitive

experiment. Further, that position is illogical since it assumes there is a second, impenetrable, free-space light barrier there, in the medium, beyond the lower-speed, already-penetrated barrier.

The theme has a tenacious hold on parts of the scientific community as well. Robert L. Forward:[4]

It is difficult to go to the stars. They are far away, and the speed of light limits us to a slow crawl along the starlanes. Decades and centuries will pass before the stay-at-homes learn what the explorers have found. ...If standard rockets are used to propel a space vehicle, the vehicle will be limited in its terminal velocity to a small fraction of light speed.

(But Bob, there'll be no "starlanes" if we are not permitted to establish them!) Those few lines contain too many (six) downer words and phrases to list, so they have been underlined instead. It is essentially one entire downer passage; in addition, it may unfortunately suggest that rocket propulsion is no better at attaining high speeds than any other kind of propulsion - say, light sailing. Sorry to say, such a depressing outlook - and an erroneous one in our view - is all too common. It is directly traceable to Einstein's reality view of special relativity which is today being seriously questioned by a few of us.

An alternate view now gaining popularity is that the distortions of special relativity, in the words of two early 20th-century Cornell University physicists, F. K. Richtmyer and E. H. Kennard, are only "a sort of *kinematical perspective*" like the optical illusion of a rod stuck in water that appears to be bent but is straight, or the stars that appear as mere points of light but are much more than that. The practical results of such a change in view are most profound in that we can no longer be certain that we are "limited... to a small fraction of light speed" or even to 99% of c . Showing how we might exceed lightspeed while not violating relativity is what this book is all about. Relativity is taken as a given; the devil lies in its interpretive details.

Einstein's retraction -

Einstein died in 1955. Twenty years later, cognitive scientist Massimo Piattelli-Palmarini discovered a hitherto unrecognized human characteristic that he calls *cognitive illusions*.^[5] Such illusions color one's thinking - even that of a genius. Thus there is now a scientific basis for questioning Einstein's early reality view of the relativistic distortions which led to his conclusion of an impenetrable light barrier.

But beyond that, it has come to our attention since the publication of the first (2004) edition, by way of Mendel Sachs, that Einstein later "changed his mind";^[6] and that circa 1921 Einstein came to see that Poincaré was right concerning the reality vs. non-reality controversy of the relativistic distortions. However, it seems Sachs suffered from an anomaly in thinking. While he showed passion about the view that the relativistic distortions are kinematical only, thereby seeming to nullify the twin paradox, going into our discussions he remained a strong supporter of the light barrier with its conflicting requirement that the variables be real! Indeed, it appears he equated the light barrier with relativity itself as many seem to do, writing in a 1 Nov. '04 letter to this writer:

"[The light barrier] has to do with the logical basis and meaning of the theory of relativity."

However, less than two weeks later Sachs modified his seemingly rigid stand:

"The reason that nothing can move faster than c is that in sr c is the maximum speed of propagation of (any type of) force. The reason that a body moves (effect) is that it was caused to do so by a force (originating in another body). If the body would move faster than c the force could not catch up with it to make it move the way it does!"

...Mendel Sachs, physicist,
State U. of NY at Buffalo, 13 Nov. '04

It appears he is on a track headed for convergence with ours, and he may soon see that accelerating beyond the speed of light comes down simply to a matter of obtaining traction.

In another exchange, a view quite like Sachs 1 Nov. '04 view is seen:

“I believe that Special Relativity is correct and consequently exceeding the speed of light in the conventional way (just accelerating more and more) is impossible.”

...Don Lincoln, experimental physicist,
Fermilab, 3 Feb.'05

I reminded him (21 Feb.'05) that Enrico Fermi (after whom Fermilab is named) apparently saw no conflict in the view that relativity is correct but the light barrier is not absolute. The following conversation is reported to have taken place in the summer of 1950 between famed physicists Enrico Fermi and Edward Teller:[7]

Fermi: Edward, what do you think? How probable is it that within the next ten years we shall have clear evidence of a material object moving faster than light?

Teller: Ten to the minus sixth. [One chance in a million.]

Fermi: This is much too low. The probability is more like ten percent.

The significance of that conversation is that neither gentleman (both of whom ostensibly saw relativity as “correct”) put the probability at zero. Hopefully, everyone who holds the view that <relativity> EQUALS <light barrier> will seriously re-examine it. Equating the light barrier with relativity is a common mistake that continues to be made even after Einstein retracted his reality view in 1921. An impenetrable light barrier does not follow from the constancy of the speed of light postulate.

In another e-mail from Lincoln:

“While it is true that I know of no practioner that takes relativistic mass seriously, it is also true that I know of no practioner that does not take relativity extremely seriously.”

...Don Lincoln, 8 Feb. ‘05

Those are not opposing views, as his words seem to intimate. What he seems to mean by “[no one] takes relativistic mass seriously” is that no one sees additional substance as being packed into a body as a result of its motion. Not a universal view, but one that this writer fully subscribes to. The relativistic increase of mass is only a reflection of the distortion of a (constant) mass’s gravitational field when moving. [8] (Cf. the cover illustrations.) It is just as magnetism reflects the distortion of a (constant) charge’s electric field when moving.

If an emissary from Megalopolis at the hub of Galactic civilization had arrived at Earth 100 years ago to clandestinely and deliberately dissuade Humanity from attempting to reach the stars, the effect could hardly have been more devastating than what has actually transpired. We are truly captives of our own doubts & fears, superstitions & beliefs, which often masquerade as superior knowledge, and which hold us back even while our dreams and instincts work to carry us onward and outward.

When an audience hears, “You can’t go faster than light,” everyone acquiesces; and when it is added that “Einstein said so,” then everyone turns to his neighbor and nods. No one asks why. That, my friend, constitutes a religious mode of thinking, not a scientific one.

We are not, each and every one of us, able to invest the time required to gain a full understanding of relativity but we do not want to appear ignorant; so we tend to fall back on authority to fill in the gaps. We may even adamantly defend authority in such occasions, forgetting in the heat of battle that authorities are humans, not gods. Leaps in faith which an authority has made as to the meaning of this or that equation may be called “genius” but they are best treated as challenges. Paradoxes signal one type of challenge.

The challenge of the twin paradox had been met in 1905 by Poincaré, and Lorentz, if not in that exact form, with Lorentz saying, “but I never thought that this [time transformation] had anything to do with real time,” but few accepted their resolution; nor did Poincaré, agree with Einstein’s idea of an impenetrable barrier at the speed of light. Then when in 1922 Einstein wrote: “Poincaré, in my opinion, is right,” everything turned upside down but nobody noticed; Poincaré, was unable to speak out, being dead by that time. Then in 1971 Sachs noticed.

In one short statement Einstein had admitted that his early view concerning the reality of the relativistic effects was only an opinion, and that he was now recanting that view. At a minimum, that affected his conclusions relative to (1) the clock hypothesis (out of which came the twin paradox) and (2) our (in)ability to exceed the speed of light.

Relativity is said to be mathematical physics; but throughout the 20th century special relativity was also a social phenomenon. Its Alice-in-Wonderland spin became a century-long belief system, telling us more about the human mind than about physics. Spin echoes remain to this day in the form of firmly-held opposing views of the twin paradox, and of an absolute light barrier.

Zeno’s story “The Achilles” was clearly a challenge. It took two millenia to resolve that challenge. Let us hope that there is not a natural gestation period of that length built in to every such situation, and that a full two millenia need not pass before we can all agree to resolve the challenge of the light barrier and are able to wholeheartedly apply ourselves to the adventure which is pre-chronicled in these pages.

First and foremost, we must learn well and never forget that the light barrier is not an intrinsic part of the postulates but rather that it was a leap of faith by a perceived genius.

Notes:

[1] Albert Einstein, *Sidelights on Relativity*, 1922, Dover Publications item #24511X, Mineola, NY, page 35.

The circuitous prose that Einstein uses there and the fact that he wrote the book in German, his native language but since WWII no longer the dominant language of science, acted to keep obscure this little post-relativity book on relativity. At one point in the book he writes: “The idea of the [contracting] measuring rod and... the [slowing] clock do not... find their exact correspondence in the real world.” Then, “If one did not wish to forego a physical interpretation of the coordinates ...it was better to permit such inconsistency with the obligation, however, of eliminating it at a later stage of the theory.”

Interpretation: “The distortions of special relativity are not real but let’s stick a little longer with the view that they are,” Mendel Sachs refers to that part as a “non sequitur.” That kind of logic is denegated, being called an “alternate rationality,” by Massimo Piattelli-Palmarini; writing on pages 142 & 143 (*Inevitable Illusions*):

We have come to see that our minds spontaneously follow a sort of quick and easy shortcut, and that this shortcut does not lead us to the same place to which the highway of rationality would bring us. Few of us suffer from any illusion that the summary paths taken by our intuitions and approximations would lead us to exactly the same point to which reason and exact calculation might have brought us. But we do delude ourselves into thinking that we are thereby brought to a neighboring area, one that is close enough.

Einstein’s *grinding prose* which we’ve just been describing - the kind that tends to grind the sharp corners off a question - is again illustrated by this answer from him in a 1952 interview (according to Nahin, *Time Machines*, p.460), when Einstein was asked whether it is permissible to use special relativity in problems involving acceleration: “Oh, yes, that is alright as long as gravity does not enter... Although... the general relativity approach might be better, it is not necessary.” What does that mean, “might be better”? Isn’t this another case of MP-P’s *alternate rationality*? Anyway, aren’t acceleration and gravitation fields equivalent?

[2] Barry E. Zimmerman & David J. Zimmerman, *Why Nothing Can Travel Faster than Light... and Other Explorations in Nature's Curiosity Shop*, Contemporary Books, 1993, ISBN 0-8092-3821-7

[3] True in a sense but not in another important sense. The additional energy does not go into the source particle to increase its strength; instead it goes into a distortion of the field of the particle making its "sensed mass" appear larger.

[4] Robert L. Forward, "The Stars Our Destination? The Feasibility of Interstellar Travel," *The Planetary Report*, Jan/Feb'03, pp.6ff; *The Planetary Report* is the official publication of the Planetary Society whose membership includes many from JPL (the Jet Propulsion Laboratory) which has done much of the work connected with planetary exploration, including the building and operating of the two Mars rovers which are presently active on the surface of Mars as this is being written in early 2004. Thus it is apparent that Robert Forward (1932-2002) had the ear of a significant part of the interested scientific community.

[5] Massimo Piattelli-Palmarini, *Inevitable Illusions: How Mistakes of Reason Rule Our Minds*, 1994, ISBN 0-471-58126-7.

[6] Mendel Sachs, "On Einstein's Later View of the Twin Paradox," *Foundations of Physics*, Plenum, Vol. 15, No.9, Sep.1985, pp. 977-980

[7] Eric M. Jones (Los Alamos National Laboratory),"Letters," *Physics Today*, Vol. 38, No. 8, August 1985, ISSN 0031-9228

[8] Homer B. Tilton, "A Neoclassical Derivation of the Relativistic Factor," *Speculations in Science and Technology*, Vol.16, No. 4, 1993, ISSN 0155-7785, pp. 297-303

Chapter 3

Anatomy of the Light Barrier

Einstein's postulates of relativity as translated from his celebrated 1905 paper by W. G. V. Rosser: [1]

P1. The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of coordinates in uniform translatory motion.

P2. Any ray of light moves in the "stationary" system of coordinates with the determined velocity c , whether the ray be emitted by a stationary or by a moving body.

The first postulate says there is no unique inertial system. The second postulate says that the observed (measured) speed of electromagnetic phenomena in free space is solely a characteristic of space, and has nothing to do with the motion of source or observer. But we'll find that the same cannot be said for their energy. Maxwell found that the constant, c , called "the speed of light" can be determined from two simple static measurements; namely, the magnetic permeability and the electric permittivity of space. Elementary physics texts tell how to measure those quantities in the laboratory without using any dynamic machinery, using only a few electronic components. It is a simple calculation then to determine the value of c from that.

In the previous chapter we explored the disagreements existing in the scientific community as to the meaning of special relativity, and in particular the reality or nonreality of the light barrier. It appears from the depth of those disagreements that somewhere, somehow, science got snarled in its effort to understand relativity. Relativity is to be taken as a given.

In this chapter we attempt to unsnarl it. We begin by exploring one possible cause of the ensnarement; namely, severe misreadings of the second postulate.

Section 1. The second postulate close-up

The second postulate bears repeating:

P2. Any ray of light moves in the “stationary” system of coordinates with the determined velocity c , whether the ray be emitted by a stationary or by a moving body.

This postulate speaks only to the constancy of the velocity of light propagation. It has frequently been misstated variously as:

- (2.1) “The speed of light in a vacuum is the limit at which anything - matter or energy - can travel” (Zimmerman & Zimmerman, 1993);
- (2.2) “The speed of light in a vacuum should act as the ultimate speed limit in the Universe - no information can be sent faster” (Barrow, 2002);
- (2.3) “It is not possible for matter or energy to travel faster than the speed of light in a vacuum” (Dewdney, 2004);
- (2.4) “Nothing (radiation or matter) can propagate relative to any observer at a speed faster than the speed of light in a vacuum, c ” (Sachs, 2004, private communication received 23 Oct 2004);
- (2.5) “[It is] impossible to transmit an action from one point in space to another with a speed exceeding that of light, whether this be done by means of material bodies or by fields of force. This proposition...outranks any special law of nature.” (March & Freeman, 1962).

Actually, each of those statements is a combination of the second postulate, Einstein’s conclusion declaring a speed limit at c , and each writer’s interpretation of the matter. Fine. The problem is, the reader -

and indeed even the writer of the statement himself - may come away erroneously thinking that his statement carries the same considerable weight as a postulate. Consequently there is this recent comment from colleague Greg H: "Isn't the light barrier just part of the postulates?" Not an uncommon view, but a wrong one.

The list of respected scientists' views in that pattern goes on-and-on; and typically they would have their statement be the end of the matter. But Einstein by his own characterization only *concluded* from the supposed reality of the relativistic distortions that there is a limit to rocketship motion at the speed of light - i.e., a *light barrier*. But his conclusion may be viewed as simply a challenge. One can come down on either side of that challenge and still be faithful to the postulates. That challenge deals only with the *physical interpretation* of mathematical relativity, which is still up for grabs until such time as something like the Grand Experiment described in later chapters is performed. A lesser experiment, such as the one with π -mesons described by Max Born (see later), does not settle the matter as some may think.

The second postulate grew out of the need to give explicit recognition to the well-established finding that there is no *luminiferous ether* - a supposed medium once thought needed to enable the propagation of lightwaves and radiowaves - and to show that the speed of a light beam as measured by all observers is the same. There never was a supposed *kinematical ether* to enable rocketship motion, and so the common idea to lump rocketship motion in with photon motion in the second postulate is most curious, perhaps revealing an imperfect understanding of the unique way light propagates; or reflecting an actual desire (A) to have lightspeed be "the limit" (#2.1), "the ultimate speed limit in the Universe" (#2.2), or (B) to have superlightspeed be "Impossible" (#2.3, 2.5), and "Nothing [can attain it]" (#2.4). It becomes clear that false postulates such as the five listed are simply declarations of (mis)understanding.

In fairness, the idea to lump may stem from the photons-energy-matter connection; energy in the form of photons cannot move faster than c , and since matter in motion also transports energy, there appears to be that connection. But a rocketship does not present the same velocity profile to all observers as photons do - a crucial distinction that makes all

the difference. Rocketships are not photons; photons are an energy quantization concept, totally unlike mass particles.

Just a word about #2.2: that is the only statement of those listed that mentions “information.” It is almost certain that that is not what Barrow intended, for Norbert Wiener observed in 1948 that information is neither matter nor energy, writing for emphasis, “information is information” in his book *Cybernetics*; and Landauer showed in 1996 in the journal *Science* that there is no minimum energy requirement for sending information. Therefore it would seem that the sending of information *per se* does not fall under the purview of relativity at all.

The speed of a rocketship depends on who measures it; the speed of a photon does not. Information is another thing altogether.

It would be wrong to lump rocketships and information into the second postulate along with photons. The second postulate belongs to photons.

The second postulate is needed to recognize and acknowledge that stated unique character of photons - the absolute, non-relative nature of their velocity. And indeed it is that characteristic of photons or electromagnetic radiation - and of gravitons too or gravitational radiation, we suppose since they, too, go at speed c (Einstein, Dirac, Wheeler) - that leads to the “equipotentials” (isochrons) in the cover illustration being spherical, shown in cross section there as circles (and not ellipsoidal or elliptical as at least one text has portrayed them). This depiction leads directly to the relativistic factor $1/\sqrt{1-\beta^2}$ for masses as shown elsewhere,[2] and supposedly to magnetic field for electric charges as we have yet to show formally; although the proof (if one exists) must be implicit in the usual formulation of magnetic field.

Even though the speed of photons as measured in space by all observers is c independently of an observer’s speed, photon energy is another thing. Electromagnetic energy is not independent of the speed of the observer relative to the source of the radiation as a result of the

Doppler effect and Planck's law. Photons always impinge on a moving observer at speed c , but their energy continually drops as the speed of the observer away from the source of radiation continues to increase. Right at the speed of light the frequency, f , and the photon energy, E , drop to zero.

It is clear that the second postulate does not apply to rocketships. Rocketships do not normally move with "the determined velocity c "; indeed, they would be expected to go far slower than that and it would be hearsay to declare that they cannot go faster as well. The difficulty is that such a declaration actually originated with Einstein in 1905, without concurrence by Lorentz or Poincaré; was then reinforced by him in 1916; yet it was recanted by him in 1921 when he stated that he now believed "Poincaré is right," a fact brought strongly to light by Mendel Sachs 50 years later in 1971. But the full significance of Einstein's change of mind still has not sunk in today. Even Sachs in 2004 was not yet comfortable applying it to the question of the reality vs. nonreality of an absolute light barrier.

Einstein's 1921 talk is recorded in the 1922 book, *Sidelights on Relativity*. Einstein wrote in such a way as to minimize the impact of that news, but there will be no minimizing such big news once it is widely disseminated and fully appreciated. That book is available from Dover Publications as their item #24511X. It may become more valued than his landmark 1905 paper among pioneering stellar'nauts, for it tells how to break the light barrier.

<p style="text-align: center;">EXTRA! EXTRA! "ARCHEOLOGICAL DIG" UNEARTHS EINSTEIN'S REJECTION OF HIS OWN LIGHT BARRIER</p>

Lumping Einstein's conclusion of a light barrier in with the second postulate has been a popular pastime; but what, really, is the relationship of the two? And how do we get from *Sidelights on Relativity* to the above headline? Here's how: Starting with his 1905 paper,[3] Einstein's stated basis for his conclusion that a rocketship cannot exceed the speed of light was his interpretation that c "plays the role of an infinitely great

velocity.” He would later write it somewhat differently (*Relativity*): “For the velocity $v=c$ we should have $\sqrt{1-\beta^2}=0$, and for still greater velocities the square root becomes imaginary. From this we conclude that in the theory of relativity the velocity c plays the part of a limiting velocity...” ($\beta=v/c$). But it seems that such a conclusion makes sense only if we assume that the relativistic distortions reflect real variables, not kinematical ones. That was Einstein’s admitted view but it was not the view of Lorentz and Poincaré. And then in 1921-22, Einstein came over to the other side, writing:[4]

“*Sub specie aeterni* [Under the final analysis] Poincaré, in my opinion, is right. The idea of the measuring-rod and the idea of the clock coordinated with it in the theory of relativity do not find their exact correspondence in the real world [!]”
...A. Einstein

The above passage is as direct a statement as any we’ve seen of this nature made by Einstein. But Einstein had given up little; Poincaré was unable to celebrate; he had already died in 1912; and being only a “sidelight,” few hardliners would read the piece through clear eyes; those who did and said so would be labeled “crank” by others. Of course anyone can read it for oneself and, to put it bluntly but accurately, those who do not will not be working from a complete database. The young and unindoctrinated may be able to see the statement clearly, but waiting for them to become a force represents another delay in tearing down the barrier. This quotation attributed to Planck seems to apply: “A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually expire.” What a terrific argument against immortality!

*A light barrier for rocketships is not implicit
in the second postulate as is often thought.*

The light barrier has not yet fallen. Barriers are like that; it seems they must run their course. One need only trace the paths of some historic man-made barriers: the Great Wall of China, the Maginot Line, the Berlin Wall; and of some natural barriers: the 1000-mile Great Barrier Reef of Australia, the pre-Columbian “The Ocean Sea cannot be crossed” barrier, the pre-1947 Sound Barrier, and the pre-Sputnik “Whatever goes up must come down” barrier. Those latter are only conditional barriers that we learned to overcome.

We see the light barrier also as a natural barrier which we might learn to “sail over” as we sail over the Great Barrier Reef, or perhaps “punch through” as we now punch through the sound barrier. The ferocity with which some of my friends object to such a suggestion indicates that they are working largely from an emotional database rather than a logical one. It is like a religious belief to some.

Quoting from Sachs: “Einstein then went on to say that, in spite of the foregoing comment, we should temporarily support the use of the length and time transformations as though they were *physically* real”! Sachs referred to that statement as a “non sequitor” - a kind of fig leaf. Sachs’ Sep.1971 article in *Physics Today* pointing that out was roundly attacked by readers. Passions can run high in dispassionate scientists.

Einstein died in 1955, apparently never having said in so many words that his light barrier for rocketships was not real and that it had outlived its usefulness. However, he did admit that he had introduced an “inconsistency,” and he urged us (his survivors) to “eliminate [the inconsistency] at a later stage of the theory.” It seems he thought that either view would take us “close enough” to the truth. Sachs found it takes us to an opposite pole in the case of the twin paradox.

The *ad hoc* hypotheses -

In addition to the two postulates of relativity these less-well-established hypotheses are encountered in works on relativity: *The Clock Hypothesis*, referred to by Rosser as “Einstein’s suggestion” (p.408) and an “extension of the theory of special relativity” (p.413), and out of

which has grown the “twin paradox”; and *The Light-Barrier Hypothesis* or “principle” (March & Freeman), characterized by Einstein as a “*finden*” or “conclusion” (p.43 of *Relativity*). Those two hypotheses are often taken as having been proved by relativity, but of course they are not; they can only be finally proved or disproved by a grand experiment like the one which is the subject of later chapters.

There is also a “hypothesis of locality,” so called by Nahin (pp.469-70, *Time Machines*), which says there is an instantaneous equivalence of an accelerating traveler and a co-moving (unaccelerating) observer. But this can be true only if the unaccelerating, co-moving observer is embedded in a gravitation field equal to the acceleration of the accelerating traveler. This is required by the principle of equivalence.

Section 2. The barrier: absolute, or only conditional?

Albert Einstein: “The rigid [metre] rod is thus shorter when in motion than when at rest, and the more quickly it is moving, the shorter is the rod. ...From this we conclude that [the velocity of light is] a limiting velocity, which can neither be reached nor exceeded by any real body.” He did not teach that the rigid rod “appears” shorter but that it *is* shorter. That stance is referred to here as *Einstein’s reality view*. Also note that his declaration of a light barrier was just a conclusion inferred from the distortions of special relativity, and based on his assumption that those distortions are real, reinforced by the discovery of an actual barrier for accelerated particles.

Today there is this trend:

Scientists are coming more and more to the view that special relativity is a kind of kinematical perspective.

Henry Margenau: “If sense data alone were recruits for reality, its domain would be ill-defined.” Thus while Einstein’s light barrier may always be apparent, that does not mean it is always real.

Twentieth-century science writers generally continued to follow Einstein's pre-1921 reality view; however, Rosser wrote (1964) this provocative passage but then seemed to back away, giving examples only of ineffectual faster-than-light phase velocities:[5]

It must be stressed that the theory of special relativity does not say that one cannot have velocities exceeding the velocity of light in vacuo, but simply says that energy and momentum cannot be transmitted with a velocity exceeding the velocity of light in vacuo.

Under the kinematical perspective view and in light of the second postulate of special relativity, the last part of Rosser's statement might be modified and expanded, without contradiction, to read: *but simply says that electromagnetic energy and electromagnetic momentum are transmitted at the finite velocity of light resulting in observed distortions of space, time, and mass when observing fast-moving objects.*

While relativistic distortions are subject to being sensed by our instruments as well as by our eyes, it would be silly to think that our mere act of observing can effect, in this way, changes to the body being observed. Especially apparent when it is considered that different observers see the changes differently.

There is also this: The up-to-now popular pastime of assigning a speed limit to a rocket is a non sequitur;[6] for when someone declares, "Lightspeed is a limiting velocity for your ship" our Rocket Rider must respond with "Lightspeed relative to what?" He needs a reference. Colloquially, **there is no road in space** along which to post a sign for rocketships reading:



True believers brush off this observation. They simply cannot be bothered. Occasionally one of them might respond with something like, "...Relative to anything or anybody."

Then RR may respond with a raised eyebrow and an "Oh, really."

"And the speed of my Cessna does not depend on whether it is measured relative to the air or relative to the ground? Is that what you're saying?"

Defensively: "Hey, I'm only repeating what Einstein said."

RR: "I don't think so. Maybe you need to begin again."

The cable-car model -

On the one hand, a sailing ship which depends on light from the sun to accelerate it remains in that way connected to the sun; its reference is the sun, and its speed is limited to less than the speed of light, c , relative to the sun. Propulsive energy cannot reach a ship traveling away from the sun faster than that. *It is limited to the speed of light for the same reason a cable car is limited to the speed of the cable.* It is riding on, and being pulled along by, a lightbeam. Einstein wondered what it would be like to ride on a lightbeam. It may simply be like riding on a cable car.

A sailing ship is limited to that speed, c , by design, not by some inscrutable, overarching, outranks-everything-else *Law of Nature*. So when the ship reaches that speed it coasts, and coasts, and coasts without being further accelerated. A speed limit - an actual speed limit - exists for it. On the other hand if the ship carried a back-up rocket it could now be lit to provide additional thrust and further acceleration.

Most designs to go really fast have so far been designs to ride on a lightbeam: the solar sail, the solar ion drive, solar thermal propulsion, particles in a particle accelerator. So of course they are limited to the speed of light; they are designs for cable cars where the cable is a lightbeam. Now we have two designs which are outside that mold: the rocket and the Bussard interstellar ramjet. Of those, the Bussard ramjet would seem to hold the most promise because it is not required to bring along large amounts of fuel.

"Little cable cars / Go halfway to the stars" according to Tony Bennett, but it takes a 1G jetship to go all the way and back in a timely fashion.

By design, San Francisco's cable cars are clearly limited to speed "C," the speed of the cable.



By contrast, Chuck Yeager's Bell X-1 rocketship is not limited to speed "C," simply because there is no cable. Nor is it limited to the speed of sound as many had thought it would be right up to the last minute on 14 October 1947.

A conventional rocket or interstellar ramjet flying free in space is self-propelled and disconnected from earth, sun, and all other possible references and so is not limited to the speed of "the cable" for there is no cable.

Its speed might be referenced to some luminiferous ether; but there is no luminiferous ether.

And so it accelerates, and accelerates, and continues to accelerate for as long as the engine operates. To those watching on Earth there might appear to be a limit just before they lose sight of the ship's laser beacon when energy can no longer reach anyone back there on Earth.

This book is about star travel but it is not science fiction; it is a **science story** describing a scenario centered around a fresh look at relativity in the light of current thinking. It is written at a level designed to appeal to the technically-savvy layman and amateur scientist. A wide, popular audience is sought to swamp the myriads who take the phrase "You cannot exceed the velocity of light" on faith alone or who generalize from a too-narrow base. A large number of scientists are among those myriads; it seems their thought processes defer to Einstein's early views and unthinkingly ignore, or are unaware of, his later views.

Indeed, one prestigious scientist (JB, citation on request), writer of more than a dozen popular science books, makes this erroneous statement in a 2002 book: "The product of the permeability and permittivity of space [is] equal to the square of the speed of light..." Of course it is not that, it is the reciprocal of that. The importance of the correct relationship, $c=1/\sqrt{(\mu_0\epsilon_0)}$, to relativity is discussed here in an appendix to a later chapter. If one uses an incorrect relationship, then that connection, which is important to understanding, will be obscured and scientists who follow JB will not see it.

Three new analyses -

Three new analyses are presented, two of which show that a barrier at the velocity of light does indeed exist for a light-sailing ship and for subatomic particles which are electrodynamically accelerated. Then in the third analysis, that of a conventional rocket or Bussard jetship, no light barrier is found to exist under the kinematical perspective view; and the reason lightspeed presents a barrier in the first two cases becomes clearer than ever.

There are these four points which we now embrace:

- (a) Maxwell showed the speed of light to be an electromagnetic property of space;
- (b) the light year is only a measure of distance.

And under the kinematical perspective view there are these additional points:

- (c) time distortion described by special relativity is only an appearance without being “real” in the sense that Einstein taught before 1921;
- (d) the general relativity environment (acceleration/ gravitation) can truly affect the running of clocks which depend on atomic processes for their timekeeping and in that sense the distortion is real; and while all atomic processes would be expected to run slower under increased gravitation fields, biological processes, pendulum-regulated clocks and balance-wheel-regulated clocks would not be affected in the same way; and it seems needlessly abstruse to say that the rate of flow of “time itself” is affected by the presence of a gravitational field.

Time distortion under general relativity is reminiscent of the clock problems faced by early transoceanic sailors; those problems were finally solved by clocks designed and built in the particular tradition proven by John Harrison in the 18th century.

Two directly opposing camps have developed over the past century: those who maintain that there is an absolute speed barrier at the speed of light, and those who maintain there is not. The powerful draw of the first camp is that Einstein initially placed himself there: “*c* plays the part of a limiting velocity which can neither be reached nor exceeded by any real body.”

And now we find ourselves faced with Mendel Sachs’ 1971 “archeological dig” from the 1921-22 era, and we must ask: *Why did we need Einstein to tell us, in a “change of mind,” that the relativistic variables are kinematical, not real, variables?* Others have told us but few have listened. The “why” should be obvious: it is because Einstein

has been the authority and the focus of the science of relativity for the past 100 years; eclipsing Poincaré, Lorentz, and all the others, fairly or unfairly.

It still is not widely appreciated what it was that Sachs dug up in 1971. Even Sachs himself appeared to support as late as October 2004 the popular reading of the second postulate (#2.4) quoted at the beginning of this chapter, having applied Einstein's change of mind only to the twin paradox,[7] not immediately seeing that it also bears on the reality of the light barrier in a quite dramatic way. But in a further private communication dated 13 Nov 2004, Sachs conditioned his stance:

“The reason that nothing can move faster than c is that in sr c is the maximum speed of propagation of (any type of) force. The reason that a body moves (effect) is that it was caused to do so by a force (originating in another body). If the body would move faster than c the force could not catch up with it to make it move the way it does!”

This positions us to accept that an engine which effectively has “*traction to space*” can propel us beyond the speed of light. A rocket is such an engine, and it seems that a Bussard jetship is also.

Notes:

[1] The two postulates in the original German from Einstein's 1905 paper, “Zur Elektrodynamik bewegter Körper,” *Annalen der Physik*, June 1905, pp. 891-921; Appearing on page 895:

1. Die Gesetze, nach denen sich die Zustände der physikalischen Systeme ändern, sind unabhängig davon, auf welches von zwei relativ zueinander in gleichförmiger Translationsbewegung befindlichen Koordinatensystemen diese Zustandsänderungen bezogen werden.
2. Jeder Lichtstrahl bewegt sich im “ruhenden” Koorninatensystem mit der bestimmten Geschwindigkeit V , unabhängig davon, ob dieser Lichtstrahl von einem ruhenden oder bewegten Körper emittiert ist.

[2] Homer B. Tilton, "A neoclassical derivation of the relativistic factor," *Speculations in Science and Technology*, Vol.16, No. 4, 1993, ISSN 0155-7785, pp. 297-303

[3] Art.4,"Physikalische Bedeutung der erhaltenen Gleichungen, bewegte starre Körper und bewegte Uhren betreffend," Page 903: "Für Überlichtgeschwindigkeiten werden unsere Überlegungen sinnlos;

For $v > c$ after consideration our sense becomes;

"wir werden übrigens in den folgenden Betrachtungen finden,

we come to find, by the way, in the following examination

dass die Lichtgeschwindigkeit in unserer Theorie physikalisch die Rolle der unendlich grossen Geschwindigkeiten spielt."

that lightspeed in our physical theory plays the role of an infinitely great velocity.

Compare p.43 of *Relativity*.

[4] A. Einstein, *Sidelights on Relativity*, Dover item #24511X, ISBN 048624511X, pp. 33, 34

[5] W. G. V. Rosser, *An Introduction to the Theory of Relativity*, Butterworths, 1964, p. 183: An example of an ineffectual phase velocity (not one of Rosser's) is the speed of the trace on the screen of a high-speed oscilloscope which can easily exceed the speed of light. Another example is of a row of LEDs which are all switched on at the same time, simulating an infinite speed of propagation for a point generating a line.

[6] "Speed," the magnitude of the velocity vector, is sometimes used colloquially when the vector nature is not critical to understanding.

[7] Mendel Sachs, "On Einstein's Later View of the Twin Paradox," *Foundations of Physics*, Plenum Publishing, Vol. 15, No. 9, Sept. 1985, pp. 977-980; It may be interesting to note in this connection that the progenitor of the twin paradox, namely the clock hypothesis, appeared in Einstein's 1905 paper but not in the 1931 English translation of his book of 1916, *Relativity*, which mirrors that paper in other ways.

Chapter 4

Acceleration Due to Light Pressure

Newton's laws of motion according to S.Chandrasekhar, Newton's Principia for the Common Reader:

- 1. Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.*
- 2. The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*
- 3. To every action there is always opposed an equal reaction; or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.*

The first law says that matter has a property of inertness, or *inertia* - it persists in its state of motion; the second law gives an order and line to that property. And the third law gives it a magnitude and direction. We might add to the third law, “But when the body accelerates, the reaction force lags the action force by a Δt which depends on the speed of light”.[1] Read “right line” as *straight line*, and read “change of motion” as *change of momentum*.

A push is on by the *Planetary Society* to launch an interplanetary sailing vessel, a vehicle whose sails would be filled by light pressure from solar radiation to push it along. They call it *Cosmos I*. An attempt was made to launch it on 21 June 2005 but the launch vehicle failed to lift it to its intended orbit. [Planetary Report, May/June 2005, p.2] Such an experiment may indeed produce some useful results. Their journal, *The Planetary Report* for Jan-Feb '03, suggested that method of propulsion be used for a starship which we'll refer to as *Cosmos II*; page 5: “[Some]

have concluded that light sailing is the only technology we know of today that can enable interstellar flight.” We felt a comparative analysis of the acceleration to be expected from such a plan was in order. This analysis is based on the assumption that the magnitude of the mass to be accelerated is the relativistically-apparent mass. It appears next.

Analysis - (First appeared in *MATH POWER*, Nov ‘03,”Acceleration”)

In the theory of special relativity, it is chosen to define force as the time rate of change of momentum. Thus the Balance of Forces Equation is:[2]

$$F = ma + v \, dm/dt \quad (1)$$

and $F=ma$, the low-speed form of Newton’s second law of motion, follows when m is constant.

Under relativity, even if the driving force is constant the acceleration (a) will not be if it appears to the motor, or to the *Essential Observer* (someone at rest relative to the motor, or moving with the motor) that the mass (m) of the ship varies.

But conversely, if the mass is assumed constant with the driving force variable there is also a barrier. We will perform both kinds of analysis. [3]

From special relativity the mass of the ship, as seen by an inertial observer picked at random from anywhere in the universe, is $m=m_0/\sqrt{(1-\beta^2)}$ where m_0 is the ship’s *proper mass* (its intrinsic mass or rest mass) and $\beta(=v/c)$ is the speed of the ship relative to the particular observer picked, normalized to the speed of light.[4] The Essential Observer is the only observer who counts in the Balance of Forces Equation, eq. (1).

With $v \, dm/dt = m\alpha\beta^2/(1-\beta^2)$ it is found from eq. (1) that $a=(F/m)(1-\beta^2)$, and

$$\alpha = (F/m_0)(1-\beta^2)^{3/2} \quad (2)$$

with the velocity of the ship (β) being specified relative to the Essential Observer.

Light sailing -

The second postulate of special relativity tells us that the speed of propagation of light is constant (at 300 Mm/s) as measured in any inertial system without regard to the relative speed of that system. However, the relative speed of the observer system is important to the amount of energy received from a source.

For light sailing, the defining formula for the driving force is $F=pA$ where p (pressure) is proportional to the energy in the beam, with that energy being subject to the Doppler effect because of the Planck relationship $E=hf$ (energy is proportional to Doppler frequency) according to the factor $(1-\beta)(1-\beta^2)$. [5] For constant mass and varying force, that is the acceleration. See that it drops to zero at $\beta=1$

Putting it all together we find that the acceleration of Cosmos II would be proportional to $(1-\beta)(1-\beta^2)$ If it were to be assumed that – both force and mass vary, applicable for $0 \leq \beta \leq 1$. Thus for $\beta=1/2$ the acceleration drops to only 37.5% of its initial value and for $\beta=1$ it drops to zero.

And that is why there is a light barrier in this case.

The ship is a sop or gift - *a sacrificial lamb* - to the gods who would limit us. We actually brought the limit on ourselves by designing a ship in which the driving motor - the light source - stays at home, meaning the driving flux from the motor must chase the ship in order to push it. As the ship nears the speed of light relative to the light source, the driving flux still impinges on the sail at the speed of light but it has run out of steam, by Doppler and by Planck, as just explained.

If $(1-\beta)(1-\beta^2)$ is graphed, [6] it will be seen that the acceleration drops faster than linearly as vehicle speed increases. A further braking effect not taken into account by this analysis relates to the inverse-square law of radiation.

A sop to the gods -

For subatomic particles in a particle accelerator, a similar analysis yields similar results.

In both this case and the previous case of the light-sailing ship, the barrier arises because the driving flux energy is unable to chase and reach a body going at or faster than c . A second reason may be that the Essential Observer sees the mass of the body as increasing towards infinity as it is accelerated; so in this sense the increase in mass is real. *Note that in neither case does the motor travel with the accelerated body.*

The driving motor - the system of accelerator coils and electrodes in the case of the particle accelerator - is fixed to the laboratory, and the driving flux from that motor must chase the particle. When the driving flux energy cannot reach the particle it is no longer accelerated and we say the particle has encountered a speed barrier or limit. *But it is the driving flux energy which has encountered a speed limit, not the particle itself.* The particle is receptive to further “push” but none is forthcoming.

<h2 style="text-align: center;">THERE IS A DRIVING FLUX SPEED LIMIT</h2>
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Notes -

[1] The fact that the speed of propagation of forces, maximally c , is not infinite is crucial. The third law says there could be no change in the state of motion of a body if the reaction force responds or adjusts itself immediately, with no time delay, to changes in the action force. (For then there would be no net force.) But of course the concept of an instantaneous reaction is a non sequitur when a cause-effect sequence is involved. So there is a time delay which depends on the native characteristics of the ambient space. In free space the governing characteristics are the magnetic permeability μ_0 and the electric permittivity ϵ_0 , giving a characteristic or “resonant” speed of propagation of cause-effect of $c=1/\sqrt{(\mu_0\epsilon_0)}$ as found by Maxwell.

From this we conclude that the magnitude of inertia in a given hypothetical parallel universe with a value of c different from ours would

depend on the value of c in that universe. And since by the Galilean-Newtonian-Einsteinian *principle of equivalence*, gravitational mass is just another aspect of inertial mass, then it would follow that the strength of gravity in a given universe depends, as well, on the value of c there.

[The reason there is no simple numerical relationship between the values of c and the gravitational constant (in our universe) can be simply explained by saying that our standards of measurement of speed (meters per second) and of mass or force (kilograms or kilograms-force) are inconsistent.]

[2] See for example W. G. V. Rosser, *An Introduction to The Theory of Relativity*, Butterworths, 1964; UDC#530.12, p.181.

Equation (1) also agrees with Newton's second law of motion as he stated it in the form "The change of motion is proportional to the motive force impressed, and is made in the direction of the right line in which that force is impressed." Read "change of motion" as *change of momentum*; and read "right line" as *straight line*. See S. Chandrasekhar, *Newton's Principia for the Common Reader*, Clarendon Press, Oxford, 1995, ISBN 0 19 81744 0, page 23.

[3] *The analysis to follow was inspired by the work of a scientist at Fermilab – who make the remain anonymous even though the analysis is in agreement with and supports his experimental findings.* Static gravitational effects result from two properties of a ponderable (mass) body: its *strength* and its *field*. Its strength is manifested by the rate at which it emits quanta (gravitons); the body is the *source* of gravitons. The emitted quanta form the body's field, structured as nested spherical "equipotentials" (*isochrons*) which expand at the speed of light relative to the observer. Thus when the body itself moves away from the observer at nearly the speed of light, those isochrons pile up in front of the body as seen by the "stationary" observer.

When a body is being *acted on* by an external force field, the incoming field acts directly on the body without going through the body's own field. By contrast, when the mass of a body is being *sensed* it is only the field of the body that is sensed. Note the dichotomy. And when a

body moves, its field effectively increases because it distorts in just that way; but the strength of the source remains at its at-rest value.

When it is said that the relativistic mass of a body is $m_0/\sqrt{1-\beta^2}$, that refers to the sensed mass. The factor $1/\sqrt{1-\beta^2}$, is supplied by the field distortion resulting from the body's motion. For this mathematical analysis see Homer B. Tilton, "A neoclassical derivation of the relativistic factor," *Speculations in Science and Technology*, Vol.16, No. 4, 1993, ISSN 0155-7785, pp. 297-303.

The energy that one pumps into a body to accelerate it goes entirely to distorting its field, effectively increasing the average value of that field (making it look like the field of a stronger source), thus affecting the sensed mass of the body but not its acted-on mass. Its acted-on mass is thus permitted to remain forever constant at m_0 . To one on the ground, that distorted field represents stored or potential energy. To one riding on the body there is no distortion of the body's field.

When the body tickles the speed of light, the incoming accelerating force from the ground can no longer reach it and the body no longer accelerates - no more energy can be pumped into the field from the ground; it is *saturated*; but if a local motive force can be recruited to act directly on the body - as from an on-board rocket engine - then it will accelerate once again with its speed increasing still more. The field can only react, doing whatever it must to reflect the increased velocity of the body; notably a Čerenkov shockwavefront forms. This "super-saturated" result does not represent additional potential energy available for use on the ground.

[4] Although the relativistic factor $1/\sqrt{1-\beta^2}$ is imaginary in the mathematical sense for $\beta^2 > 1$, its applicability has only been shown to be valid for $\beta^2 < 1$; and it is easy to find a derivation which has that form for $\beta^2 < 1$ but not for $\beta^2 > 1$. Consider this integration corresponding to the isochronal patterns of the cover illustrations:

$$\frac{1}{2\pi} \int_{-\pi}^{\pi} \frac{d\theta}{1 - \beta \cos \theta} = 1/\sqrt{1-\beta^2} \text{ for } \beta^2 < 1, \text{ but } = 0 \text{ for } \beta^2 > 1.$$

That integrand is the same for all β , both in the relativistic realm below lightspeed and in the superrelativistic realm above lightspeed. This analysis appears in *Speculations in Science and Technology*, Vol.16, No. 4, ISBN 0155-7785, 1993, pp. 297-303. While in a sense the “energy of motion [is] converted entirely into mass” (Zimmerman & Zimmerman), the increment is contained in the field distortion, none being packed into the mass-particle itself.

The strength of a source particle is here hypothesized to remain constant at its rest value, whether the particle is a mass-particle or an electric charge. When in motion the added kinetic component is called *the relativistic increase of mass with velocity* in the case of a mass-particle, or *magnetic field* in the case of an electric charge. Each kind of source particle continues emitting quanta (gravitons or photons) at a constant rate, according to its “strength” (proper mass or charge), no matter how fast or slowly it moves.

William R. Smythe, *Static and Dynamic Electricity*, (1950, p. 565): “The first postulate of special relativity requires that the laws of electrostatics shall be identical for all observers. If we assume, in addition, that the magnitude of charges is the same for all observers, we shall see that it follows that the ... additional forces [which we might call] electrokinetic forces ... are identical with those we have already called magnetic forces.” [Underlining emphasis added.]

In keeping with the idea that the core mass (i.e., the strength of the mass-particle) remains constant, Don Lincoln of Fermilab wrote in a personal communication dated 8 Feb 2005: “While it is true that I know of no practitioner that takes relativistic mass seriously, it is also true that I know of no practitioner that does not take relativity extremely seriously.” I.e., this idea does not sit in opposition to relativity despite possible first appearances. This is in agreement with the above analysis.

[5] A is sail area, p is light pressure, $k=2/c$ with c being the speed of light, U is the energy in the light beam.

[6] Comparative graphs appear in *MATH POWER* for Nov ‘03, ISBN 1087-2035; [www.ddj.com/Dr.Dobb’s Math Power newsletter](http://www.ddj.com/Dr.Dobb's%20Math%20Power%20newsletter).

Appendix 4A

The Maxwell-Schelkunoff analog and the speed of light

The universal constant called “the speed of light” is seen as resulting from a *resonance phenomenon* analogous to the resonant frequency of a parallel inductor-capacitor tuned circuit in an analogy flowing directly from James C. Maxwell’s work. We refer to the fact that $1/\sqrt{LC}$ is the free-space speed of light (or the resonant angular frequency of a hi-Q parallel tuned circuit), where L and C are the magnetic and electric constants characteristic of space (or of the tuned circuit). In the first instance, “L” and “C” are the universal constants permeability μ_0 and permittivity ϵ_0 , respectively.* In the second instance they are network inductance and capacitance. Engineer Schelkunoff first broached this analogy in connection with antenna design.**

The units of permeability are henries per meter (H/m); those for inductance are henries. The units for permittivity are farads/m (F/m); those for capacitance are farads. Space, the domain of permeability and permittivity, is a continuum; thus the “per meter” part is necessary. An inductor and a capacitor are lumped circuit constants, thus the absence of “per meter” there. If we consider radio-frequency transmission-line or

* Since c is defined as exactly 299 792 458 meters/second and μ_0 is defined as exactly $4\pi \times 10^{-7}$ henries/meter, then ϵ_0 is also an exact number of farads/meter; neither ϵ_0 nor μ_0 is a rational number however.

** S. A. Schelkunoff, “The Impedance Concept and its Application to Problems of Reflection, Refraction, Shielding, and Power Absorption,” *The Bell System Technical Journal*, Vol. XVII, No.1, January 1938, pp. 17-48 - The “impedance” referred to in the title is the *intrinsic impedance* of space, about 377Ω (exactly $4\pi \times 29.979\,245\,8$), the analog of the *characteristic impedance* of an LC circuit. The “Q” of truly empty free space, and its resonance peak, would be infinite; but even in free space, the barrier is momentarily lowered by accelerating through it, just as an FM signal effectively lowers the resonance peak of a tuned circuit. Impedance, and therefore Q and the “height” of the light barrier by analogy, are normally defined for a constant-frequency signal; therefore it is difficult to analyze the FM case, the analog of rocketship acceleration. For such an analysis in terms of Bessel functions see for example R.W. Landee et al, *Electronic Designers’ Handbook*, McGraw-Hill, 1957, section 5, pp. 27-32. See also the author’s 1968 analysis in terms of a *generalized impedance* definition, “An Electronic Analog of Relativistic Space,” in *Electron and Ion Beam Science and Technology*, Robert A. Bakish, editor, The Electrochemical Society press.

waveguide theory, then the correspondence becomes exact, with “per meter” being appropriate in all four cases.

Radio engineers are especially well equipped because of their knowledge of transmission lines, antennas and waveguides, to understand the why and wherefore of the second postulate. Landee, et al, state on page 20-5:*

It can be seen from Eq.(20.12) that, a transmission system will be nondispersive if it is without dissipation ... Under these conditions, [we have]

$$v_p = v_c = 1/\sqrt{\ell c} = v \quad (20.22)$$

where v = velocity of light in a vacuum.

Plain as day, the velocity of an electromagnetic wave in a nondispersive transmission line, also in free space, is just c , the so-called velocity of light; and that is due to the product ℓc , with units of *henry farads per meter squared*. The reciprocal root of that is just *meters per square root henry farads*, with “square root henry farads” reducing to seconds ($\sqrt{HF} = s$), giving finally m/s, the same as the units for the velocity of light, and we’ve come full circle. Everything fits.

Throw a rock into space and it carries energy through space, it’s true; but a rock is only a rock. Space is not affected by movement of the rock through it. However, launch an electromagnetic wave into space and ripples are produced in the fabric of space itself. No rock needed. Not even a miniscule particle or corpuscle.

* Landee, Davis, and Albrecht, *Electronic Designers’ Handbook*, McGraw-Hill, 1957; Library of Congress Catalog Card Number 56-6898

Two ways to launch energy into space in the form of electro-magnetic radiation are to excite space as with an electric spark or with the launching of a wave from a transmitting antenna. In both cases it is the measured speed - the speed anywhere along its path as measured by any inertial observer - that is determined by the associated electric and magnetic constants. Once launched, the wave has no sense of wherefrom it was launched. It does not have that reference. It is now *a child of empty space*, generating and regenerating itself over and over, in its electric and magnetic components, as it moves outward. That's all in accord with the second postulate.

If you want to understand the second postulate you must “think like an electromagnetic wave.”

In accord with the second postulate and in accordance with this analysis, that speed, c , for the radiation will be seen by all inertial observers, no matter where the wave is launched from, as being the same simply because of the first postulate - yes the FIRST - and the fact that the permeability and permittivity of space are both static - not dynamic - quantities; their measures do not change no matter if the observer is moving with velocity $\frac{1}{2}c$, c , or $2c$ relative to the source of that energy. In other words, the second postulate flows out of the first. They are not independent; the second postulate is “proved,” and is no longer just a postulate.

The root of the problem many have understanding this may be the fact that Einstein's photon represented to many a resurrection of the ancient particle theory of light just at a time when everyone was coming to accept the wave theory as espoused by Maxwell. The photoelectric effect is what influenced Einstein; no one could yet explain the photoelectric effect in terms of the wave theory. But Planck had only recently opened a door to that understanding with his *quantum* of light, and such understanding might have come soon.

If you think long and hard about it, Einstein's photon is most probably just an electron in disguise. Consider the light-emitting diode (LED); it is said the LED “converts” electrons to photons; but electrons are simply caused to vibrate, launching an electromagnetic wave; and so the energy comes out in packets. The photoelectric effect might be explained as simply the reverse of that process.

Ciufolini & Wheeler called c “the characteristic speed of space.” Now we see it as *the resonant speed of space*. It sets the speed at which electromagnetic energy, and other “primordial forces” (C & W’s term) (meaning primarily gravitation) normally and naturally propagate through empty space but it clearly does not set the speed at which rocketships and atoms move. We may rarely or never see things moving faster than light, but we do see things moving far slower than that every day. Although light normally moves at the resonant speed of space, atoms do not; this fundamental difference shows that photons and atoms are two different breeds of “particles”; thus Eddington’s term “wavicles.” We cannot put photons and atoms in the same camp. And even though electromagnetic energy is always measured to be c , that does not in itself justify the assumption that a rocketship cannot exceed that speed.

The second postulate of special relativity, the constancy of the velocity of light, follows from the Maxwell-Schellkunoff analog and the first postulate since the permeability and permittivity of free space do not depend on the speed of anything (by the first postulate a relevant experiment performed on a fast-moving rocketship would give the experimenter the same results as those obtained on Earth); and thus the second postulate is encompassed within the first postulate (the universality of physical laws). In material media where permeability, μ , and permittivity, ϵ , are increased over free-space values, the speed of light is understandably reduced according to $1/\sqrt{\mu\epsilon}$ to give the index of refraction (as of glass) of the product $\sqrt{(\mu/\mu_0)}\sqrt{(\epsilon/\epsilon_0)}$.

Also now better understood, because of the dependence of the “speed of gravity” on the product $\mu\epsilon$ as well, is the reduction in the speed of light inside gravitation and acceleration fields that is recognized in general relativity.

ANALOGOUSLY

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A banjo string is plucked by a fingertip.

The string resonates - it “sounds” - as the energy of the pluck is transferred to it.

The characteristic resonance of the string sets the sound frequency.

Friction and other effects conspire to make the sound go from strong to weak and away.

The sound is now a ghost but its frequency never changed.

A point in space is shocked by a spark.

The space resonates - it “lights” - as the energy of the shock is transferred to it.

The intrinsic resonance of space sets the light speed.

Doppler, Planck, and a super-fast rocketeer conspire to make the light go from violet to red and away.

The light is now a ghost but its speed never changed.

Photons, those nonparticulate quanta, are born going at lightspeed, they spend their lives there, and they die there. They behave that way because they are not “things” like a rock or a jet plane, as Sachs pointed out.

Just as Ptolemy did not have Newton’s theory of universal gravitation (1666) to guide him when he presented his theory of the universe, and just as Thomas Young did not know of the functional existence of rods (1866) nor have Seeley and Avin’s simple two-receptor circuit for frequency discrimination (1947), so, too, Einstein did not have the Maxwell-Schellkunoff analog (1938) or know of Cerenkov radiation (1934-37) when he wrote in his epic 1905 work, “We find that the velocity of light in our physical theory plays the roll of an infinite velocity,” ostensibly because that’s the fastest light will go. We now know that’s like saying a plucked banjo string vibrates at a frequency which is effectively infinite because that’s the highest it will go.

And he (Einstein) appears to have gotten off-track by assuming that the distortions of special relativity are real - a view not shared by either Lorentz or Poincaré. When an authority interprets a theory incorrectly, that can set humanity back hundreds of years. Einstein's relativity seems to have been okay; it agrees substantially with Lorentz' and Poincaré's; only his initial interpretation of it was not quite right, a fact which he later (1921) came to see. Geniuses are people too.

Cerenkov electrons -

In a lossy medium such as water, the "Q" is less than infinity as it would be expected to be in totally empty space.* Thus while a projectile would have to be shot out of a gun with infinite energy in order for it to even closely approach 300 Mm/s (megameters per second) speed in free space, the Maxwell-Schelkunoff analog suggests that a large enough energy might easily be imparted to such a projectile to make it cross into the free-space superlightspeed realm in such a lossy medium. It might then follow that the Cerenkov electrons in the moderating baths of nuclear reactors today are, unbeknownst to us, actually going significantly faster than 300 Mm/s. An experiment might be designed to measure that speed without breaking the budget. Possibly someone at CERN has already performed that experiment but has not widely publicized the (perhaps positive) results.

* Q is a dimensionless ratio, a figure of merit or efficiency of a rotating, oscillating or vibrating circuit or body. The Q of a tuned circuit is a measure of the height and narrowness of its resonance peak. For a dissertation on the subject, see: Estill I. Green, "The Story of Q," *American Scientist*, 1955. Green gives Q values for various systems ranging from 10 (golf ball) to 10^{13} and beyond (spectral lines and planet Earth).

Appendix 4B

The roles of speed and acceleration

To say that the speed of a material body needs no reference would be illogical. Even the hobby pilot knows that airspeed and groundspeed are not the same thing. The first is the speed of an aircraft through the air, the second is its speed across the ground. They are not the same unless there is no wind. We say that the air and ground, respectively, are speed references for the aircraft. The speed of the International Space Station (ISS) over the ground is thousands of miles per hour, and a shuttle in the process of docking has the same high speed; but if we specify the relative speed of the ISS and a docking shuttle, then that relative speed is near zero - exactly zero upon capture.

So of course a spacecraft needs a speed reference; the Galactic cloud or the Earth or the ISS for instance.

As for acceleration, that is given by the Balance of Forces equation. Only the speed of the craft relative to the Essential Observer is important in the Balance of Forces equation. The Essential Observer is someone at rest relative to the motor which propels (accelerates) the spacecraft. The Balance of Forces equation which governs the acceleration of the spacecraft is eq. (1): $F = ma + v \, dm/dt$, where $m = m_0 / \sqrt{1 - \beta^2}$ with β being the speed of the spacecraft relative to the Essential Observer, normalized to exactly 299.792 458 megameters per second (Mm/s).

The way is now clear to a fuller understanding of relativity, especially the second postulate which is most-often questioned. Understanding requires not only a thorough understanding of relativity, but of radiowave theory as well.

Chapter 5

Light Sailing Is Not All There Is

[Some] have concluded that light sailing is the only technology we know of today that can enable interstellar flight ... Louis D. Friedman, Executive Director, Planetary Society, The Planetary Report, Jan, Feb '03, p. 5

Don't you believe it. Carl Sagan (1934-1996) put his money on the Bussard interstellar ramjet.

The Galaxy is permeated by a rarefied cloud or mist - a *tenuous atmosphere* - which rotates with it, and in 1960 Robert W. Bussard proposed tapping into that interstellar cloud. His engine, classed as an *interstellar ramjet*, in one version would collect the cloud material enroute to use as a working fluid and would use a nuclear reactor as a source of energy to heat and expand it, and expel it in a powerful jet to propel the ship.[1]

Following up the analysis presented in ch. 4, it is well established that an increase in the mass of a body or a ship will be seen by all who are not moving with the ship. However, the increase is not absolute; its magnitude is observer dependent, and only the Essential Observer - someone at rest relative to the motor - counts in the Balance of Forces equation, eq. (1), as has already been discussed.[2]

Rocket dynamics -

Challenge After Challenge (1)

Before rockets in space became commonplace
It was said they wouldn't fly;
For there is no air to push against there,
But now they do work we find.[3]

And before superlight speed "was" a *fait accompli*'d
It was said we needn't try;
For Einstein declared light speed is barrier'd,
Tho' later he changed his mind.

Continues

A key point commonly overlooked with rocketships is that the Essential Observer is not someone on Earth, he is our Rocket-Rider for whom $\beta=0$; taking eq. (1) right back to the low-speed form of Newton's second law, $F=ma$ with $m=m_0$, which is *now relativity qualified*, meaning that a constant jet force will most certainly produce a steady acceleration because the motor travels with the ship and the driving flux does not have to chase it from the ground. The increase in mass of the ship, including its fuel supply, as seen back on earth, is not seen by the Essential Observer on the ship, and so that increase is not real in the way it was with the sailing ship and the particle accelerator.[4]

Those on the ground will see the mass of the ship as increasing without limit; they will also see the jet thrust as getting larger as the ship continues to accelerate. Those on the ground will see, too, at sublight ship speeds, a continually decreasing acceleration for the ship; but under the kinematical perspective view, that and the other two ground-based observations are only appearances. Mass and jet thrust do not "really" increase; acceleration does not "really" drop. ...Any more than stars in the sky are really points of light.

The traditional relativist would say that ship speed is really limited to c and that ship time really dilates as it appears to those on the ground to do. However, the new relativist's view may turn out in reality to hold instead; namely, the view that rocketship speed really increases without limit and ship time is really the same as Earth time for a constant 1G acceleration. The choice rests with the question of whether or not the relativistic distortions reflect real changes to the moving object. Contrary to what is commonly thought, the theory of relativity supports both views.

While it seems to this observer that the new relativist's view better fits the requirements of Occam's Razor, we won't know for sure which view is the truer until after the Grand Experiment (GX) has been performed. Although men and women are to be sent into interstellar space in the GX, the missions will be programmed to return them to Earth in eight years for each of its two phases.

Only an actual round trip can resolve the question of who's interpretation is the right one, for the final results under the two interpretations - principally astronaut aging - will be quite different.

Those on the ground may not be able to directly see a ship going at, say, 110% c relative to the galactic cloud, but they will receive evidence of it in the *Cerenkov radiation* produced by the ship's wake in the galactic cloud. (Cerenkov radiation was unknown until its discovery by Russian physicist Pavel A.Cerenkov (Cherenkov, Čerenkov) in 1934-39, well after Einstein had formulated his theory of relativity.) If the ship's motor is turned off at that time, forward energy will be lost through Cerenkov radiation until its speed drops to lightspeed relative to the galactic cloud at which point no more Cerenkov radiation will be produced. After that, simple, mundane resistance presented by the galactic cloud will continue to slow the ship but now at a lesser rate. Because of the tenuousness of the galactic cloud, if the captain orders **"ALL STOP,"** meaning to stop all engines, that will not result in the rocketship quickly coming to rest in its medium (the galactic cloud) the

way an ocean sailing vessel does, but for a superlightspeed ship, it will slow to lightspeed relatively quickly in a dense galactic cloud.

Challenge After Challenge continued (2)

Yes, Einstein we find did change his mind

In a '21 lecture obscure.

Mendel Sachs pointed out Einstein's mention of doubt;

His words in English we find.

In a talk quite amazing, he said (paraphrasing):

"The barrier's no longer for sure.

"Photons move along at the reciprocal root of mu epsilon.

"But rockets are not so confined." [5]

Continues

The question arises: Why did we even need for Einstein to "change his mind"? Are the rest of us all incapable of rational thought? But then I suppose we needed someone to lead the way; and who better to tear down this wall than the one who erected it in the first place.

Project SETI expanded -

The speed of an ocean-sailing vessel can be referenced to the ocean waters; the speed of an aircraft to the air it passes through; and the speed of a starship can be referenced to the galactic cloud. But why should that cloud present a speed limit to spacecraft any more than a planetary atmosphere presents a speed limit to aircraft? Perhaps no one has said it does, precisely; but there is this generally overlooked clue:

Even the concept of a speed limit in space is a non sequitur simply because there is no all-pervasive luminiferous ether - no absolute frame of any kind to which the speed of any vessel can be referenced.

The second postulate of special relativity affirms that.

When someone says “you cannot exceed the velocity of light” that only means (1) that you cannot push a ship from the ground faster than light, and (2) that we will receive no direct visual evidence of a ship moving away from us faster than light. Relativity predicts both points. Point 1 is true but rockets do not push from the ground; and point 2 would be true were it not for the Cerenkov radiation expected to be produced by a superlightspeed ship, unknown to Einstein until 1934 when Cerenkov predicted it and in 1939 found it.

Challenge After Challenge continued (3)

And so we give pause just as to the cause
Of the gamma-ray bursts in the sky -
One a day, like vitamin A.
Per'aps from ships going at superlightspeed?

...Breaking the light barrier, like a Harrier
Jump Jet breaking the sound barrier on high
As it once again confounds the speed of sound?
Then that would be scary indeed.

NB: Meantime, John Middleditch of Los Alamos Nat'l Lab. has presented an explanation of the gamma-ray bursts in a four-page *Astrophysical Journal* letter (ApJ 601,L167, 2004).

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Thus we might reasonably expect that a rocketship can exceed the speed of light relative to the galactic cloud; and we can expect to see a “luminal flash” (compare *sonic boom*) as the Cerenkov shockwave from such a superluminary ship gives rise to broadband electromagnetic (and gravitational) radiation. Project SETI might be expanded to look for such deep-blue luminal flashes, or x-ray or gamma-ray bursts. Perhaps it already has.

A few others have also concluded there is no light barrier but for other reasons. Smarandache:[6] “There is no speed barrier in the universe.” His reasoning was based on an interpretation of the *entanglement phenomenon* of quantum physics. This point must be

stressed: *The concept and the fact of superluminary speeds would violate only the popular interpretation of relativity*; there would be no violation of relativity itself. It is fairly certain that communication is not limited to lightspeed, simply because information is not matter or energy.

The homesick Centaurians -

Alpha Centauri is the nearest star, being 4.3 light years distant. The G4-sun component of that binary system is similar to our own G0 Sun so Alpha Centauri is a perfect focus for our first 'manned interstellar adventure.

If we are ever to reach the stars we must first get our heads together, start thinking like homesick Centaurians, and get to work. Antimatter engines, wormholes-on-demand, and something resembling warp drive may come in time for intergalactic flight but we don't need them just to get "home." ...Such a short distance by comparison.

Early in the 20th century relativity developed a popular cult-like following due to the Alice-in-Wonderland spin it was given, and spin echoes remain to this day. Back then we were told that a moving meter stick would truly shrink and objects would truly get more massive without limit, and that time itself would truly slow; but appearances do not always conform to facts, and isn't time just a parameter used to keep track of change - at most an "abstract continuum" as David Landes called it?

H. G. Wells' time machine -

H.G.Wells' 1895 story, *The Time Machine*, is only engaging fantasy, yet it appears that some scientists take the idea of time travel as serious science. [But when the respected physicist John A. Wheeler was asked what he thought, he recited a seemingly unrelated poem according to Nahin (p. 362).] The presumption for such stories is, in itself, paradoxical because it requires two kinds of time to exist simultaneously at any given place: the time our perennial Wells sees (from inside his time machine) on a clock external to the time machine and the time metered by the flow of his consciousness (presumably the same as the time he sees on his pocket watch) - both chronometers supposedly accurate timekeepers yet running quite independently and differently as a

result of a “temporal field” generated by the Time Machine separating the two regions.

Norman: “Describe to me a new hypothetical property, any property at all that you may desire, and I will gladly ‘field’ it for you! You want a temporal drive? Here. I give you a ‘temporal field’ to explain it and a ‘temporal core’ to implement it.” Norman writes science fiction. P. A. M. Dirac understood. He conjured up a “creation operator” and an “annihilation operator” - serious mathematical tools for quantum mechanics. And that is a good thing.

But, dear reader, mathematics is one thing and physics quite another. One must never forget that. Margenau: “A theorem of mathematics can be true yet have no bearing upon reality.”

When we attempt to “spacify” time - that is, treat it as just another (a 4th) dimension like the three of space - it seems that a new kind of time - a 5th dimension - pops up.[7]

And what if our hero is time traveling in a second time machine contained within the first? Then wouldn’t a third kind of time, a 6th dimension, pop up? Who can accept such a proliferation of time dimensions as an actual possibility?

Would Occam of Occam’s Razor fame have been comfortable with it? Could it be that time is not like space except in some of its mathematical properties? ...And that the characterization “spacetime continuum” is sadly misleading to many students of science - even some highly accomplished ones?

Einstein’s time machine -

The prediction of *relativistic time dilation* begs for attention. One version called the *clock hypothesis* [8] was first told in the context of special relativity by Einstein in 1905 at age 26.[9] In a later version of the tale called the twin paradox (not Einstein’s version), a space traveler ages little by comparison with those who stay home.

But that scenario clearly must be treated under general relativity which Einstein did not develop for another 7-10 years. And if a steady acceleration of 1G were maintained throughout the trip, there should be no effect from that quarter, with special relativity giving no permanent “set” in time because of the variable’s kinematical nature. Sachs reports

that Einstein later came around to this view.[10] It is also interesting to note that in Einstein's small book *Relativity* (1916,18), we could find no mention of the clock hypothesis.

Differing accounts have surfaced since Einstein's death in 1955. In a 1959 book (*Relativity for the Layman*, p.71, Penguin Books), J.A. Coleman concluded: "Hence, there is no permanent effect and, of course, no paradox." W. Cochran (*Vistas in Astronomy*, Vol. 3, p. 78, Pergamon Press, 1960): "It is amusing to find, in view of the controversy on the aging of space travelers, that in the simplest form of space travel, the traveler ages most!" The popular culture, however, sticks to the original version that says the traveling twin ages less because of his high speed away from or towards Earth. Mallove and Matloff subscribe to this view:[11] "To be sure, some people will refuse to be convinced and will continue to doubt the reality of what should really be called the 'Twin Effect'." They thereby attempt to shame the non-believers ("some people") into accepting their "reality" view. Nahin does a similar thing:[12] "The clock hypothesis is generally assumed to be true. Einstein [1905]... took the rate of a clock's timekeeping to be velocity dependent ...However, one can still find those who object. In this book I side with Einstein." Nahin then proceeds to present "proof" of it, citing experiments involving *accelerated* motion!

Those three authors, until at least 1989/1999, sided with the 1905 Einstein, whom the 1921 Einstein himself had abandoned, the last personality finally admitting "Poincaré, is right." Poincaré, had not predicted a barrier; the barrier was Einstein's 1905 conclusion.

The Galilean-Newtonian-Einsteinian *principle of equivalence* equates gravitation and acceleration fields, and the speed of light in either kind of field is found to be less than c , its *Lorentz speed*.[13] Since atomic processes are regulated by the speed of light, atomic clocks run slower under increased gravitation or acceleration; atomic processes slow; but to conclude that the rate of all processes would then slow - that *time itself* would slow - seems an oversimplification.

A pendulum clock runs faster under increased gravity; and the aging of space travelers depends on the affect of gravity on biological (not atomic) processes. An atomic clock built to track Greenwich Mean Time while on Earth would run fast on Mars because of the lesser gravity there;

but a balance-wheel timepiece would operate the same in both places because such a timing mechanism is immune to differences in gravity and straight-line acceleration.

It seems likely that interstellar navigation simply calls for a certain kind of clock, just as transoceanic navigation did before the call was answered.[14] An ideal balance-wheel clock is needed; or possibly an atomic clock with its time display tempered by a g-sensor signal. Or we might simply maintain a steady 1G acceleration/deceleration during the entire trip.

What is the truth? -

In the story of the twin paradox, why is it never said that the space traveler, when he returns home, is much shorter and more massive than his twin? ...Or thinner, depending on his orientation in the rocket. For surely that would follow if it truly follows that he is much younger. The three transformations are the same mathematically. Perhaps that would be too silly to mention. But the question must be addressed nonetheless. [15]

At this juncture in history there simply is insufficient reason to believe that a rocketship trip to Alpha Centauri and back must necessarily consume an inordinate amount of either "Earth time" or "ship time." A *Relativity Cadre* consisting of the best space-enthusiast relativists - to include radio hams because of their special knowledge of the electrical properties of space - needs to be assembled to find the best way to proceed.

Relativity may not need a mathematical retooling but it is due for some heavy-duty reinterpretation. At this point it looks as if we may not only be able to get "home," but get there in a reasonable time if we maintain 1G throughout the voyage - accelerating to the halfway point and decelerating the rest of the way; thus our clocks and our bodies will remain on "Earth time" throughout the entire voyage.

Summing up-

We have presented an uncommonly optimistic scenario, and there will remain those who say we are being naïve. But this should not deter us; history's roads are paved with the dust of prestigious naysayers who were wrong, and there is no final proof that such a scenario could not play out pretty much as related here given a truly concerted effort. Indeed, without a Herculean effort we may never achieve star travel, leaving ourselves forever vulnerable to all in this vast universe who do. And, it seems fair to say, no one doubts that the universe is indeed vast and that vulnerability is a bad thing.

Guglielmo Marconi first announced, by radio, our presence to offworld SETI watchers in 1898 and our cover as a dead world was blown. If there is a star-capable civilization within 105 light years, a probe may already be on its way to us; and if from ϵ Ursae Majoris, Capella, Castor, Arcturus, Pollux, or Vega, we might feel its first effects tomorrow. But it will be 33 millennia before our signals reach the center of the galaxy assuming they survive the trip at all. Might we be able to outrun those signals and get there first?

Notes-

[1] An account is contained in M&M: Eugene Mallove & Gregory Matloff, *The Starflight Handbook: A Pioneer's Guide to Interstellar Travel*, John Wiley & Sons, 1989, ISBN 0-471-61912-4.

[2] It is just an *apparent increase*. That is the so-called "relativistic increase of mass with velocity" and is probably no more than a manifestation of field distortion due to the ship-to-observer (or observer-to-ship) relative motion, which is dependent on the constancy of the speed of light (the second postulate). It is no doubt the same kind of phenomenon that acts with moving charges in which case the increase is called *magnetic field*.

[3] In this writer's first-hand experience, the common take on the subject of rockets in space in the 1930's was that they wouldn't work there because *there is no air for the jet blast to push against*. [I think the

real reason people said that was because they were afraid to go there. ...HBT] Also during that period in demonstrations of possible future television systems, sound was not employed. That prompted one student to ask me, “When television finally arrives, will it have sound?” Those were not deep thinkers. Those memories prompt me to wonder today, in a “give me a break” moment: How deep-thinking are those who insist that *we don’t ever need to try flying faster than light because we “already know” it can’t be done.*

[I think the real reason people say that is because they are afraid to go there. ...HBT]

[4] The relativistic increase of mass with velocity is real in the same sense that the magnetic field of a moving charge is real. To one riding on the charge there is no magnetic field.

[5] As reported by Mendel Sachs on page 978 of “On Einstein’s Later View of the Twin Paradox,” *Foundations of Physics*, Vol.15, No.9, Sep. 1985; A. Einstein, *Sidelights on Relativity*, pp. 35-6:

“Geometry (G) predicates nothing about the relations of real things... Poincaré, in my opinion, is right. The idea of the measuring rod and the idea of the clock coordinated with it in the theory of relativity do not find their exact correspondence in the real world.” This announcement represented a sea change in Einstein’s thinking. Thus, in light of his earlier expressed conclusion that there is a universal light barrier because the geometric effects are real, we are led to the paraphrasing.

[6] Florentin Smarandache, *Bulletin of Pure and Applied Sciences*, Delhi, India, Vol. 17D (Physics), No.1, p. 61, Jan-Jun, 1998

[7] Read all about time travel in Paul J. Nahin’s 600+ page book, *Time Machines*, 2nd ed., Springer-Verlag, 1999, ISBN 0-387-98571-9. An impressive chronicle. Don’t look for answers there, but the epilog (pp.355ff) presents an interesting give-and-take on the subject by some leading scientists.

[8] W. G. V. Rosser, *An Introduction to The Theory of Relativity*, Butterworths, 1964; UDC#530.12. See sec. 3.1 and 11.2.

[9] A. Einstein, “Zur Elektrodynamik bewegter Körper,” *Annalen der Physik*, Leipzig, 1905, pp. 891-921).

[10] Mendel Sachs, “On Einstein’s Later View of the Twin Paradox,” *Foundations of Physics*, Vol. 15, No. 9, Sep. 1985, pp. 977-80

[11] Eugene Mallove & Gregory Matloff, *The Starflight Handbook: A pioneer’s Guide to Interstellar Travel*, J. Wiley, 1989, ISBN 0-471-61912-4, p. 249

[12] Op. cit., ref. 7, pp. 460-1

[13] We speak of the index of refraction, n , of glass, the ratio of c to the speed of light inside the glass which, is $< c$ because of the strong electric and magnetic fields there in accordance with the Maxwell-Schellkunoff analog. Gravitation and acceleration fields, too, have a similar effect. Rosser, p. 452: “The numerical value of the speed of light depends on the strength of the gravitational field.”

[14] See the TV movie *LONGITUDE* dealing with the impact of clock design on navigation. Or see the related book *REVOLUTION IN TIME* by David S. Landes from Harvard U.P., 1983, republished by Barnes and Noble, Inc., 1998, ISBN 0-7607-1074-0.

[15] The difference is that mass does not accumulate or “run on” the way time seems to; but this comparison points up that the time variable appearing in the Lorentz transformation $t/t^1 = 1/\sqrt{1-\beta^2}$ is not the “running on” or *psychological* kind of time, as Lorentz knew and as Mendel Sachs pointed out. It is “only a ‘*measure*’ of duration...no more than a *scale change*” as if there were, say, “eight numbers on the face of a clock instead of the usual twelve.” And when the traveler returns home, his age will not have been affected by the periods of unaccelerated motion, no matter what the relative speed.

Lorentz (Born, p. 222): “A new time measure must be used in a system which is moving uniformly.” And, “But I never thought that this [transformed time variable] had anything to do with real time.”

This scenario has been considered by Mendel Sachs on p.76 of Mendel Sachs’ 1993 book, *Relativity in Our Time*: “Would the proponents of the idea that relativity theory predicts that the twins should age asymmetrically also claim that they would be different sizes at splashdown?”

Chapter 6

Einstein's Light Barrier

Ode to the Common Man

*And if we had not known better
We might have come to say
That a meter stick stuck in water
Is truly broken--for it looks that way--
At the surface of the flow;
If someone whom we thought should know
Told us it was really so.*

Einstein (1916):[1] “The rigid rod is thus shorter when in motion than when at rest, and the more quickly it is moving, the shorter is the rod. ...From this we conclude that in the theory of relativity the velocity c plays the part of a limiting velocity, which can neither be reached nor exceeded by any real body.” Then: “As a consequence of its motion the clock goes more slowly than when at rest. Here also the velocity c plays the part of an unattainable limiting velocity.”

Those passages bring home the sheer starkness and reasoned inevitability of Einstein's early reality view of special relativity. Einstein was declared a genius not to be questioned or doubted - a kind of scientific sainthood being bestowed; nearly everyone picked up on his reality theme, taking it as gospel.[2] And when it was found that the velocity of particles in particle accelerators was truly limited to c , that was the icing on the cake - the proof of the pudding, it seemed to many; and so we have physicist Nigel Sharp writing, “Light as a limit was not Einstein's *opinion*; it's as supported as gravity...”[3]

But can relativistic contraction and a stroke of the pen really limit us that way? ...”We conclude [that c is] an unattainable limiting velocity.” Are we to believe there is some *Venerable Force* at work behind it all which acts to turn appearance into reality?

Einstein: “Try and penetrate with our limited means the secrets of nature and you will find that... there remains something subtle, intangible and inexplicable. *Veneration for this force beyond anything that we can*

comprehend is my religion” (emphasis added).[4] And are we to believe that our logical analyses are trumped by the Venerable Force, and further that Einstein’s conclusion is in consonance with the Venerable Force? He admitted that he, himself, could not be sure - an implication to be drawn from the above quotation.

Venerable force or cognitive illusion? -

It has been said there is a religion gene in all of us; that the need for faith-based beliefs is “built in.” Perhaps a mark of genius is to be able to speculate and convince all others; to express a bullet-proof combination of fact and faith. Einstein’s work with the photoelectric effect has been variously described as “a remarkable assumption”; and by Millikan: “a bold, not to say reckless hypothesis.” Planck expressed his awe somewhat differently: “That he [Einstein] may sometimes have missed the target of his speculations, as for example in his hypothesis of light quanta, cannot really be held against him.”

According to work performed in just the past quarter century by the distinguished cognitive researcher Massimo Piattelli-Palmarini, each of us - not excluding geniuses - is subject to *cognitive illusions*. Those are “mental eyeshades”; “biases, tunnels, or blind spots”.[4] ...One might then dare to ask, “or wishful thinking?” In the matter of special relativity, there is a choice between “real” and “apparent”; and, according to the gathering storm of the kinematical-perspective view, Einstein led us down the garden path; for when we look for a truly rational proof of a universal, inevitable, intractable, impenetrable light barrier in relativity, we do not find one under the kinematical-perspective view. Further, there is now a scientific basis for seeing the “inevitable light barrier” as only an *inevitable cognitive illusion*.

Indeed, we may already have witnessed faster-than-light phenomena without recognizing them; one case involves π -mesons as described in a later chapter. And there is the notable fact that Cerenkov particles in the moderating baths of nuclear reactors are clearly going faster than the local speed of light; and while that observation is commonly minimized by saying the particles (electrons) are still going slower than the free-space speed of light, that is not known for sure. Measurements made of such electrons might establish their actual speed;

and if it turns out to be greater than 300 Mm/s, that could be the “clear evidence” that Fermi called for, first observed by Cerenkov in 1939 but with speed never actually determined. In any event, *Cerenkov particles have successfully broken the local light barrier*. And by what rationale might it be presumed there is a second light barrier in the bath at the free-space speed of light?

Recalling that the speed of light in any medium, including empty space, is the reciprocal root of the product $\mu\epsilon$, it is noted that magnetic permeability (μ) and electric permittivity (ϵ) do not have their free-space values in water. The supposed existence of a barrier in water at the free-space speed of light would be nothing more than a faith-based assumption.

Compounding velocities -

It is an elementary calculation of special relativity to show that velocities cannot be compounded to exceed lightspeed and this is sometimes pointed to as “proof” that the speed of light cannot be exceeded under any circumstances.[6] But it is important to note that in those calculations, where the first body is projected away from home base and the second body is projected away from the first body, that there always remains an unbroken *umbilical connection* to home base; there are multiple Essential Observers involved with each seeing nonzero β . Such calculations conveniently ignore that there is but one Essential Observer for a rocket *for whom β is zero*.

Compounding of velocities is a scenario of special relativity, and special relativity deals with inertial systems, not with accelerated systems, that’s why it is *special*; but the accelerating rocket is not an inertial system. To contrive to analyze the motion of an accelerating rocket using special relativity, as some suggest we should do, is to fool oneself; it depends on an illegal “alternative rationality” (Massimo Piattelli-Palmarini). General relativity, as opposed to special relativity, applies to accelerated systems; and general relativity is *not* equivalent to unlimited, repeated applications of special relativity; general relativity is a thing apart. No, rocket propulsion is *not* equivalent to an infinite compounding of velocity increments.

One of Zeno's paradoxes argues that we cannot get from point A to point B, or go beyond, by first going halfway, then halfway, then halfway again and again; and citing the compounding of velocities as absolutely limiting us to c is reminiscent of that argument. How long does it take to overcome that kind of mindset? In the case of Zeno's paradoxes it took nearly two thousand years.

Risky business -

At the risk of incurring the wrath of hard-core believers in an absolute, impenetrable light barrier, we propose that each situation be cool-headedly analyzed on its own merits. Much of the dissent encountered to this approach appears to be on a high emotional, near religious level. Well thought-out dissent is invited now; the other kind is not.

Because the motor travels with the ship, a cool-headed analysis strongly indicates that

lightspeed is no barrier for a rocketship or a jetship.

Also, reasonable doubt exists that time presents a barrier; under special relativity its variations are only appearances in the kinematical-perspective view, and under general relativity they depend on the makeup of the clock.

Electromagnetic energy propagates at the resonant speed of space there is no doubt; but it is not certain that material bodies are so restricted. Some have said that if we do manage to go faster than light we would also travel in time; but isn't that just a twist on the twin paradox? And the classical treatment of the twin paradox may now be seen as being another illegal alternative rationality because it applies the methods of special relativity to a problem of general relativity.

Venerable force or kinematical perspective? -

If the length of a meter stick moving in the direction of its length appears to be $L=\sqrt{1-\beta^2}$ as seems likely, then it might be seen to shrink to zero length for $\beta=1$; and for $\beta>1$ we have $\Re(L)=0$, meaning only that the

stick would remain unseen. The implication is that we are doing our sensing via light waves, in which case only if the speed of light were infinite would we expect there to be no distortion at any speed. However, visual/optical distortion does not equate to a real change.

Similarly, when we sense via sound waves, there are distortions related to the speed of sound. A distant rifle which fires a bullet would be sensed to hit a target next to us before we hear the blast from the gun. Only if the speed of sound were much greater than the speed of the bullet would there be no distortion. Auditory reversal of cause-effect does not equate to a real change.

To take such appearances/observations as proof of a physical barrier would mean bowing to the Venerable Force; quite a leap especially in view of the observer dependency of the contraction.

Jules Henri Poincaré in 1904 included the principle of relativity in his list of important physical principles.

The principle of relativity states that the laws of physics should be the same in all inertial frames of reference. An inertial frame is one which is not being subject to acceleration.

The principle of relativity became the first postulate.

Poincaré was less interested in the real-versus-illusion question of special relativity than he was in contriving ways to fool the senses. One such contrivance was a disk-shaped universe which has a radial temperature gradient; very hot at the center, absolute zero around the rim. Poincaré speculated on what an inhabitant of that universe, subject only to the expansion/ contraction property of heated objects, would sense upon walking from the center towards the rim. The inhabitant would shrink towards zero, Poincaré speculated, as he approached the outer rim thereby making him unable to reach the rim, like Achilles inability to reach the tortoise in Zeno's famous puzzle, "The Achilles."

Hendrik Antoon Lorentz (1927): "But I never thought that this [time transformation] had anything to do with real time." He may have recognized the analogy between relativistic distortions of space and time in the Minkowski diagram, and geometric *rotation* (a transformation of visual perception) of a spacetime coordinate system, in which *length does not shrink, it simply rotates out of our full view as time rotates more into*

it. It is an apt four-dimensional geometric analog but does not necessarily have any bearing on physical reality.

Max Born wrote: “A [metre] rod in Einstein’s theory has various lengths according to the point of view of the observer. One of these lengths, the statical or proper length, is the greatest, but this does not make it more real than the others. The application of the distinction between ‘apparent’ and ‘real’ in this naïve sense is no more reasonable than asking what is the real x-coordinate of a point x, y when it is not known which xy-coordinate system is meant.” Thus, Born strived to downgrade the importance of the concept of reality as it pertains to relativity.

Max Born compared the slicing of a pickle [cucumber] along a diagonal instead of squarely; a pickle is a pickle, says he, no matter how you slice it. Born (1962, p. 254): “Thus the contraction is only a consequence of our way of regarding things and is not a change of a physical reality.” A few pages later he considered a trip to α -Centauri, giving the traditional depressing analysis, concluding with “these space experiments cannot at present be performed,” showing he too felt the need for an actual trip.

After being distracted by Einstein’s strict reality view for several generations, more and more scientists are coming back to the Poincarean/Lorentzian view that special relativity describes appearance and a kinematical perspective which does not necessarily reflect actual physical changes.

Further relativistic experimentation of the kind outlined in later chapters is called for. The *thought experiment* without actual back-up experimentation has outlived its usefulness.

The dreams of the young die hard -

Some youngsters dream of star travel becoming routine; Einstein set a different course and dreamed of riding on a light beam it is said. That coupled with his use of *Elektrodynamik* in the title of his 1905 landmark paper - a clear association with light but used there in connection with a moving body (*bewegter Körper*) - might lead one to surmise that he based his conclusion of a light barrier partly on an unwritten hypothesis that riding on a light beam would be like riding on a rocket if only the

rocket were subject to the same upper velocity limit as light. And he may have seen fulfillment of his dream when he wrote, “we conclude that... c [is] a limiting velocity.” But Einstein’s photon is limited in *both upper and lower* velocities while rockets are not subject to a lower limit; thus the upper limit becomes suspect.

Einstein resurrected the photon as a particle of light, an idea which many thought had been put to final rest by J.C. Maxwell,[7] to explain the photoelectric effect; and he may have felt free to think of a rocket in flight as a kind of *macrophoton*. But things do not scale up and down that way as quantum mechanics came to show, perhaps explaining Einstein’s strong initial objection to that new science. Denis Brian reports that a friend said to him: “Einstein, I am ashamed of you; you are arguing about the new quantum theory just as your opponents argue about relativity theory.”

Very late in life Einstein made an astounding admission: “Every physicist thinks he knows what a photon is...I spent my life to find out...and I still do not know.” After that admission if he had ever thought of a flying rocket as a macrophoton, it seems safe to say that in his final years he did not.

Finally, we find, Einstein changed his mind -

Physicist Mendel Sachs spotted it and wrote about it in the context of the twin paradox.[8] Almost everyone else, it seems, missed it; it was “under the radar.” Yes, we all missed Einstein’s 1921 change of mind. Then in 1922 he wrote about his change of mind in a small obscure book, *Sidelights on Relativity*, which contains expanded transcripts of two talks he had given; one on May 5th, 1920, at the University of Leyden, “Ether and the Theory of Relativity,” and a second on January 27th, 1921, at the Prussian Academy of Sciences, “Geometry and Experience.” That second talk expressed his change of mind: “Poincaré was right [and I was wrong],” he wrote. Einstein repeated it in *Sidelights on Relativity*. It is clear he was referring to his previous stand on the reality of the relativistic effects, for Poincaré had not shared Einstein’s reality view.

In 1948 too, and at other times, Einstein again disaffirmed his early view that relativistic time distortion is real. But all that was still “under

the radar.” Almost no one noticed. Sachs noticed but few believed Sachs when he told them!

Previously (in 1916) Einstein had written, paraphrasing (see top of this chapter for actual quotations), “the rod is shorter when in motion” and “the clock goes more slowly when in motion” but now in 1922, it appeared he was backpedaling, writing in that round-about way he sometimes used; “*Sub specie aeterni* Poincaré, in my opinion, is right” in direct contradiction to his words of 1916. *Sub specie aeterni* can be interpreted to mean “in hindsight.” Continuing (pages 35, 36):[9]

“The idea of the measuring-rod and the idea of the clock coordinated with it in the theory of relativity do not find their exact correspondence in the real world. It is also clear that the solid body and the clock do not in the conceptual edifice of physics play the part of irreducible elements, but that of composite structures, which may not play any independent part in theoretical physics....we are still far from possessing such certain knowledge of theoretical principles as to be able to give exact theoretical constructions of solid bodies and clocks.”

Paraphrasing, “The relativistic contraction *et al* do not indicate real changes in the objects being observed, contrary to my original 1905 view.” In that way he transferred the onus of the light barrier from the spacetime continuum onto the constitution of solid bodies and clocks. Perhaps a good idea. But if the relativistic effects are not real, are only “a sort of kinematical perspective” as Richtmyer & Kennard put it, then the light barrier can no longer be considered absolute.

Even Sachs seems to have missed that connection to the light barrier initially; for when asked what his stand was on that, he gave this standard response: “nothing (radiation or matter) can propagate relative to any observer at a speed faster than the speed of light...” That response reflects a common confusion of the light barrier with the second postulate. After further prodding, Sachs qualified his stand:[10]

“The reason that nothing can move faster than c is that in special relativity, c is the maximum speed of propagation of (any type of)

force. The reason that a body moves (effect) is that it was caused to do so by a force (originating in another body). If the body would move faster than c the force could not catch up with it to make it move the way it does!” Parenthetical notes are Sachs’ own.

...Mendel Sachs (e-mail 13 Nov’ 04)

(Sachs had not yet taken the next step to see that a rocket does not require a force “originating in another body.” Shades of the old days when a rocket was said to need air to push against!)

And there you have it; the problem, independently defined! To break the light barrier we only have to find a way to obtain traction to space. As impossible as that may sound, it is a condition met naturally by rockets. A rocket does not need earth, air, *or anything*, to “push against”; that’s the *Woody Woodpecker principle*.^[11]

Finally there is no rational reason to conclude from relativity that a rocket cannot continue to accelerate after it reaches a speed of 300 Mm/s (the speed of light) going away from planet Earth.

For the reason Sachs gives, it should not be surprising to find that particle speed is limited in particle accelerators, that spaceship speed is limited in light-pressure sailing ships, and that all natural phenomena normally observed appear to be so limited. But isn’t that also why San Francisco cable cars are limited to the speed, C , of the cable? “ C is the maximum speed of propagation of force.” Of course it is.

Clearly not all vehicles are so limited. Self-propelled motorized buses are not. A rocket is self-propelled too. The rocket does not face the constraint Sachs laid down; the force driving it does not “originate in another body.”

In addition to being self-propelled, a rocket is self-contained like bus + road. A rocket has traction to totally empty space just as a bus has to the road.

Today when you hear someone say a rocket cannot accelerate to go faster than light, keep in mind that it would be hard for anyone to know whether Einstein himself in 1954 was as sure of that as he seemed to be prior to 1921.

Foolish to try?

Before rockets in space became commonplace
It was said they wouldn't fly;
For "There is no air to push against there,
"And it would be foolish to try."

We're smarter today (or so we say)
But still it is said they won't fly
Beyond lightspeed - "An impossible deed,
"And it would be foolish to try."

If the relativistic distortions were real spacetime contortions
Then the light barrier might be infinitely high;
But Einstein changed his mind and so we now find
That it wouldn't be foolish to try.

Notes -

[1] Albert Einstein, *Relativity*, 1916; Translation by Robert W. Larson, 1920; (c) 1931 Peter Smith, Crown Publ., pp. 43-4

[2] Arthur March & Ira M. Freeman, *The New World of Physics*, Random House, 1962, LoC#62-20332, p.89:

According to the theory of relativity [i.e., Einstein], nature is so constituted that its operations are limited by the value of a given constant c , the speed of light in empty space. In its most general form, this limitation states that there exists a principle of nature that makes it impossible to transmit an action from one point in space to another with a speed exceeding that of light, whether this be done by means of material bodies or by fields of force. This proposition, which Einstein deduced from his principle of relativity [is] a general regulating law that outranks any special law of nature.

and on p.76:

The systems to which the physicist must refer natural phenomena...owe their effectiveness to...the objects present in the universe. This...is the essence of the principle of relativity.

[3] “Letters”, *MATH POWER*, Vol. 2, No. 8, May 1996, ISSN 1087-2035, page 8; Sharp’s letter was in response to a topic appearing on p.1 of the previous issue.

[4] Denis Brian, *Einstein: A life*, John Wiley & Sons, Inc., 1996, ISBN 0-471-11459-6, p.161-4

[5] Massimo Piattelli-Palmarini, *Inevitable Illusions: How Mistakes of Reason Rule Our Minds*, John Wiley and Sons, 1994, ISBN 0-471-58126-7, pp. 139-41

[6] Richtmyer & Kennard 1947, p.125:

The equations just given for the transformation of velocities as measured in different frames should not be confused with the ordinary rules for the composition of two velocities measured in the same frame. The latter rules are, of course, still valid. To take a numerical example, let two electrons, ejected from a filament stationary in S , move off with equal speeds of magnitude $0.9c$, one going toward $-x$ and the other toward $+x$. Then their speed relative to each other still measured in S , is $1.8c$, by the usual rule. This exceeds c . But, if we make $u=0.9c$, so that frame S' keeps up with the electron going toward $-x$, the velocity of the second electron relative to the first, measured now in S' is $(1.8/1.81)c$ which is a little less than c .

and on pp.119,123

One might think of hurling a ball from one location to the other with indefinitely great speed, so that no correction for its time of flight would be necessary. This would, in fact, do the trick. But if all masses increase with velocity as the mass of the electron is known to do, a ball could not possibly be projected with a speed exceeding that of light. From the standpoint of existing knowledge, it is entirely possible, and it is a consequence of Einstein's new theory of relativity, that no signal can be transmitted faster than a light signal.

But only four pages later, R&K present their “kinematical perspective” argument as it might apply to relativistic contraction, apparently not thinking it might also apply to mass: “But if all masses increase with velocity as the mass of the electron is known to do...” On that score, according to one Fermilab scientist, “THIS IS NOT TRUE”; masses do not really increase. (Don Lincoln, *Understanding the Universe: from Quarks to the Cosmos*, World Scientific, 2004, p.505, ISBN 981-238-703-X.)

[7] A distinction must be made between the photon as a flying particle of light under the ancient *corpuscular theory*, and a quantum of energy as espoused by Max Planck. The latter is readily embraced under the wave theory of light, the former is not.

[8] (a) Mendel Sachs, "On Einstein's Later View of the Twin Paradox," *Foundations of Physics*, Plenum, Vol. 15, No. 9, September, 1985, pp. 977-980;

(b) Mendel Sachs, *Relativity in Our Time: From Physics to Human Relations*, Taylor & Francis, 1993, ISBN 0-7484-0118-0.

[9] Albert Einstein, *Sidelights on Relativity*, reprinted by Dover Publications, Inc., NY, 1983, ISBN 0-486-24511-X; first published by E. P. Dutton Publishers, NY, 1922; A landmark book which I immediately ordered ten more of!

[10] See *MATH POWER* (ISSN 1087-2035) for Dec '04 & Jan, Feb, Mar '05 for that full exchange of letters, "Mail Matters" dept. See also subsequent issues; particularly the Apr '05 issue, p.1: "Reinvigoration: When Einstein changed his mind"; and the May '05 issue, "Mail Matters." Those documents can be accessed at [www.ddj.com/Dr. Dobb's Math Power Newsletter](http://www.ddj.com/Dr._Dobb's_Math_Power_Newsletter).

[11] Before Columbus' time the common folk thought the world was flat; and during the 1930s & 40s the common folk thought a rocket needed air to push against. During that period the magazine *Popular Science Monthly* carried a tutorial in one issue explaining why rockets will work in outer space. Rockets had been shot some 50 miles straight up by that time at White Sands, NM.

Then in George Pal's 1950 movie of Robert A. Heinlein's story *Destination Moon*, Woody Woodpecker demonstrated rocket propulsion with a shotgun's "kick" while the narrator explained, "That kick is quite independent of the air around it. It works perfectly well in a vacuum." The launch in the movie "occurred" in June 1954 judging from a sans-a-year calendar on the wall of the lab (*which showed the first week of June as containing five days, thereby narrowing the year down to '54, '65,*

'71...) and the featuring of a mechanical differential analyzer of the pre-digital era well before 1965. In the movie it was mentioned that the WWII German V-2 rocket had the capability of flying back from the moon to the earth.

In that movie, four men went to the moon in June 1954, walked around, and started back home. In real life, 15 years and one month later, three men made the trip and returned safely to the Earth. With that 1950 movie, humanity was 90% of the way to the moon, with Neil Armstrong and Buzz Aldrin stepping onto the surface on 20 July 1969 at 21:56 EDT and 21:56+20 minutes, respectively. (*Back at the site of the planned **John McCain Southern Arizona Starport Corridor**, the neodate was 1969/WK30/Sun and the time was 18:56 PDT and AZT (Arizona time).*) Mike Collins remained in orbit, putting him just as much at the moon as anybody. Compare that 90% to the estimated 1-3% of the way to Alpha Centauri, our position today in terms of concept and accomplishment. ...HBT

FICTION: A.D.2041-2049

Chapter 7

The Phase One Experiment: The First Starship

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Any species, in order to assure their long-term survival, must continually strive to go beyond where it now is.

Terminology - *The nouns solar system, earth, moon, and sun* are not capitalized so they may be used generically. When proper names for those objects are needed, the names *Huma, Huma 3A, Huma 3B & Huma*, respectively, are appropriate. *Human* is treated as a proper name. ...Or “Earth” and “Moon” (capitalized) may be used.

Introduction -

During the 20th century stories of travel to the stars proliferated, being set in the 21st century and beyond. But still, today, such so-called science-fiction stories are more fantasy than science. *Starship Enterprise* designs from Gene Roddenberry are highly esthetic but also highly impractical in terms of present propulsion systems and other technology, and they do not well fit the needs of the space environment - perhaps being too much influenced by aircraft aerodynamic considerations. One can tell how close we are to reaching a goal from the reality/fantasy ratio of the popular literature.



In 2005 a model of the Apollo 13 moonship was available from The Danbury Mint, 47 Richards Avenue, Norwalk, CT 06857. In 2045 they offered a model of Starship Alpha.

Photo courtesy of The Danbury Mint

On that basis, we may be 1% of the way to star travel today, in 2004, and if we are ever to reach the stars it seems we must speed up while we are still able. However, judging from actual spacecraft designs of today we may be much farther along than that; perhaps 3% of the way there. It seems that science fact has overtaken science fiction in the matter of spacecraft design.

We have just entered the 21st century and it is up to our generation to take the bull by the horns. While a core of enthusiasts have a general idea of what to do, details are still in flux. Even the imposing question of propulsion remains unsettled. The *Planetary Society* has been touting propulsion by light pressure, but the Bussard-DeLauer interstellar ramjet promises to attain much greater accelerations and speeds, and do it independently of home base. Mallove & Matloff's 1989 book, *The Starflight Handbook*, is recommended reading - especially chapter 7 "Fusion Ramjets" and chapter 8 "Interstellar Ion Scoops" (John Wiley & Sons, Inc, ISBN 0-471-61912-4).

In this chronicle we proceed to get real with Starship Alpha, the first starship. Much 20th-century technology goes into it. SS Alpha is to be built in space and stay there. She is not further named in these pages, that privilege belonging to her first crew.

A plan for the design and operation of a starship will unfold in these pages. Her appearance, unpretentious. She is propelled by a nuclear reactor (as are military ships and submarines of today) which superheats a working fluid or *propellant* to produce a high velocity jet in the manner engineered by Bussard and DeLauer - in one embodiment of their *interstellar ramjet*. The propellant for the main part of the journey is to be interstellar hydrogen and the other ions which are there, collected enroute. Thus the range of SS Alpha is determined ultimately by the operating lifetime of the reactor.

If it had been written in 1939, the story told here would be classified as strictly science fiction, and if someone in 2069 were to read it portions would no doubt seem quaint; yet it is designed to reflect best knowledge as of the time of writing. Hopefully it will come across to today's reader as quite believable with only a few (but rather large!) engineering problems yet to be worked out: principally propulsion and ecosystem. The writer's plan *is to* rewrite the story every few years (health

permitting), making midcourse corrections so that the final version of the story will match a proven scenario after the goal it points to has been achieved, at which time it shall be purely an adventure story devoid of scifi.

The mission -

The mission of SS Alpha is to place a navigational buoy at a permanent location one light•year out, on line with Alpha Centauri, thus staking the first Human claim to a definite parcel of galactic space outside our own solar system. The ship will then return to Jupiter orbit, subsequently to Moon orbit, the crew finally being transported to the surface of the Earth. By the staking of that claim, notice would be served to All Creation that Humans lay claim not only to that parcel but to the entirety of our solar system as well. A secondary mission is to begin mapping the interstellar cloud with an eye to finding “jet streams,” paths of larger-than-normal particle densities.

We do not yet know what the top speed of SS Alpha will be but do not rule out superlight, its F/m_0 acceleration not being relativity limited. If the average speed is only $\frac{1}{4}$ light relative to home base, then the trip would take but four years out and four years back under the rules so far developed.

Nearly all of the ship’s operations are given over to computers, and SS Alpha requires a crew of but 12. The smaller the crew, the less life support capacity is needed, and the greater the acceleration because of the reduced mass. Passengers, pets? No. Artificial gravity? Definitely; a small price is paid for this true essential. Two genders aboard? Not this time; the social complexities still have not been worked out in submarines, a similar environment.

The main body of the ship is the habitat or *life ring*. It consists of five modules arranged in the form of a regular pentagon, the ends of each module being joined to their neighbors by angular *nodes*. The modules are all the same size, between the size of a sea-land shipping container and a standard railroad boxcar. The nodes carry airlocks and docking ports and provide stowage for spacesuits, tools, and other gear. Two modules (M3 & M4) form the *biosphere* (ecosystems/ environmental/ hydroponics). Module M1 is given over to the ship’s bridge & flight

deck containing flight/propulsion control, navigation & engineering; module M5 to life needs. Quarters for the four officers are located in the modules containing their duty stations; the medics in M4 and M5 for example. Quarters for the 8-member bridge crew are in the remaining module (M2) in four staterooms.

Crew members live in M2-type earth-bound quarters during ground training and later aboard the *academy life ring* operating as a separate space station in low earth orbit. The station normally rotates like a wheel three times a minute to provide a continual $\frac{1}{4}G$ (one-quarter earth-normal) artificial gravity.

Permission to come aboard, sir -

It's 2041. You've just finished ground training, a shared responsibility of the Air Force, Navy, NASA and the prime contractor, and you are looking forward to the next phase: in-orbit training aboard *Space Academy LR-1*, the life ring given over to preparing you for a flight nearly one-quarter of the way to Alpha Centauri and back.

On your flight-to-orbit with your crewmates, you try to contain your excitement but can't wait to start exploring "Laurie One" as she's affectionately called. The Brits in their incomparable way call her "Lorry-One," space truck, and she is that.

You recall the stories of how your great-great uncle Ben worked on the Great Northern Railway in northern Montana in the early part of the 20th century and the first simple-articulated, huge, heavy steam locomotives - named for engineer-designer Anatole Mallet (1837-1919).^{*} Those prime movers, called "foggin'malleys" by the burly men who worked on them, were reportedly able to haul 4000 long tons up a one percent grade at 10 miles per hour to build a frontier. You'd saved Uncle Ben's poem. (See Plate I.)

^{*} A powered 1:29 scale model (G. gauge) by *Astro-Craft* of this 2-8-8-2 Mallet Steam locomotive with Tender became available in spring 2005. In the winter of that year it was priced at \$593.95 from *Micro-Mark*, 340 Snyder Avenue/Berkeley Heights, NJ 07922-1595. The actual full scale original was built for the Great Northern Railway in 1929-30.

The same urge drives us now. Our new prime mover is expected to haul ass through interstellar space at near lightspeed in our efforts to push back a much larger frontier and assure that we are the fittest in the universal survival game. Right now you're so pumped you feel you could outsurvive God Himself!

Plate I

Those Foggin' Malleys, by Benjamin E. Tilton, Dec.1945

We must keep those "foggin' malleys"
A-tearin' down the rail.
A-wheezin' and a-groanin'
With that mournful scratching wail;
With a thundering, roaring, rumble -
Like moving all creation.
We must keep them rolling onward.
'Tis the life-blood of the Nation.

Give her clearance - hi-ball the signal;
Vividly her image grows.
Hear that rumbling growing closer,
Here she comes - and there she goes.
Her whistle screaming out the signal,
And the clanging of her bell.
Tearing through the wayside village
Like the windmills of hell.

On down through the fertile valley
Where the bench-lands terminate;
Groaning like some ancient monster
With her ponderous load of freight.
Dashing by those 'dobe bad-lands
With domes of scoreo
In their fantastic formation
Where the murky rivers flow.

And the veteran at the throttle
Knows her whims - her power appeal;
Pours it on in greater volume
While she's lickin' up the steel.
He's conscious of her surging rumble,
Hears her muffled straining groans;
Though a skeptic fatalistic
Or a modern Casey Jones.

Watch her take that curve ahead
With a proud and graceful swing -
Spouting out a trail of vapor
Like a monstrous living thing.
Now she's fading in the distance -
Racing toward her destination
For the survival of the fittest -
The life-blood of a nation.

Also required reading at the Academy was a technical article by astronomer Carl Sagan written in 1963 about a Bussard intergalactic 1000-ton jetship accelerating at a constant 1G through space having a proton density of $10^6/\text{m}^3$. You think to call your Starship “the friggin’ buzzard” ... ala “those foggin’ malleys.” The Captain didn’t think much of that idea. At least not at first. Maybe he could get used to it you think to yourself.

Upon your arrival at LR-1, everyone proceeds through the docking locks. You swim under zero-G in a shirt-sleeve environment with the group to M2. A corridor runs the full length of M2. Corridors, present in M1 and M2, are placed along the aft hull to provide added radiation shielding for the living and working quarters when mated to SS Alpha’s NPU (nuclear propulsion unit) as she will be during the entire mission. After everyone and everything is aboard and the shuttle has undocked, the Captain orders that the life ring begin rotating to provide artificial gravity. “That’s better,” you comment to no one in particular.

Module M2, the crew’s living quarters, consists of four staterooms for the eight crewmen. Shift assignments are such as to assure single occupancy. Each stateroom is a comfortable $2\frac{1}{2}$ by 5 by 2 meters high. There’s a lavatory with shower & minilaundry. The main laundry is located in eco module M3 near the head, a two-holer. Yes, all that biomass will be recycled into palatable and healthful foodstuffs for another trip once more’round the ol’biological loop - just as if it were being recycled in your backyard garden at home!

You examine your assigned stateroom. Your bunk is a hammock hung longitudinally along the module axis; an orientation and design chosen to best accommodate ship’s acceleration during the actual mission.

There’s a couch, desk, wardrobe and bureau, and a large viewport overlooking the earth. “Wow!” you utter as you look out, not caring who hears you. At the desk there is a video screen, video-media player/computer with internet and e-mail capability. There are electrical convenience outlets here and in the lavatory for small personal appliances like your electric shaver. Your electrical energy usage is monitored by your personal energy card that works like a smart credit card. Everything

is designed to make you feel as secure in the interstellar environment as possible.

The ship carries an extensive LDM (library on digital media) that rivals any library on earth. You'll use it to study for your masters ticket during the trip. It also contains an abundance of classic movies and videos.

During your ground training you'd bunked in a similar dormitory room at the academy located within the *John McCain Southern Arizona Starport Corridor*; but you notice differences now - especially with gravity and floors that seem to slope. Each of the four staterooms has a large mural on the wall behind the couch expressing a different topical theme. This stateroom is the *Jupiter Suite* with a painting by Chesley Bonestell. You revel briefly in the fact that all living and working spaces are normally well-lighted, helping to keep the blues at bay.

You feel lightheaded. You don't yet have your space legs. You begin stowing your uniforms and other gear. Uniforms are functional, unpretentious jump suits with built-in straps positioned as seat belts would be, terminating in velcro - the loops part - positioned to mate with the hooks part located at the various seats.

Your roomee enters. You look up and greet him with "Yo Mac!" "Name's Harley," he offers. "Mine's Norm," you respond, "although I'll be Gus the first week out!" - a reference to the shift assignments.

"Then I guess that'll make me Carp!"

You stare at each other. Then in chorus, "I knew that!" Laughter and a high five.

An academy in space -

Aboard Laurie One is heard "Chow-down in M5 commencing at 17:00 hours, followed by briefings at 18:30 and 19:30 in M1." Two identical briefings will be given so the Life Ring does not become unbalanced by everyone being in M1 at the same time. You are part of the first group. You look at your watch. Time to freshen up, change, and catch early chow. The mess, a self-serve cafeteria, is in M5. That module also contains the medical facilities, labs, and workout equipment. As you work out, energy credits get deposited into your personal energy card.

The full crew complement is on board for final training, along with two instructors who won't be going along on the mission. Since this is "the first of the first" course of its kind, the instructors will be "running like crazy" just to keep ahead of the students!

The captain and first mate (the pilot) give the briefings - really a 'welcome aboard' pep talk - followed by a reminder to review your class schedule before morning. Your first full day tomorrow aboard Laurie One will be mainly a tour to commence at 06:00 hours. Breakfast at 05:00. You'll be reintroduced to your primary duty station. Instructor Gladys says it will become "part of you" for these six weeks of training and the eight years of the mission that are to follow.

Gladys liked to joke that she would be a stowaway. The guys loved that. You joke back at her, "The captain may have his first mate, but Gladys you'll always be the girl of my dreams!"

Gladys responds, "You mean...[gesturing]...?"

"Sure. Why do you think he's called 'the first mate'?"

The first biweek is spent in theory and hands-on instruction. Most of your classes are in M1 because that's where your duty station is. The bridge-crew positions at the four forward consoles - you were first introduced to them in the ground mock-up & simulator - are, port to starboard, CCW going around the axis of the ship facing forward:

Hulk Console - S&P Engineer; spaceframe, propulsion, controls

Hacker Console - Computer engineer/Cyberneticist

Flash Console - Mission Astro-Specialist

Sparks Console - Communications, radar, displays

You are one of the *Fabulous-8* bridge crew. Your primary duty station is *Flash*, but you must also be capable-to-proficient in the other three specialties. Hacker and Flash chairs are like saddles so they can be easily mounted and dismounted from behind. The other two are also, to cut down on parts inventory you're told - except that the captain's and pilot's are regular flight chairs. Go figure.

The flight deck is also in M1, elevated behind the four forward consoles. There are two chairs with the primary flight/navigation consoles: the left chair is the captain's. During flight simulations all four

forward consoles are to be manned, and at least one of the two flight-deck officers (FDOs) will be on the Flight Deck. Of the remaining two officers, one is the Chief Medic stationed in M4/M5 and one an eco-specialist (Deputy Medic) stationed in M3/M4. They are heavily cross-trained.

The large forward viewport in M1 doubles as a display view screen. It is basically a large CRT (cathode-ray tube) with multiple electron guns external to it in space. A rear-facing camera can present a view aft on that variable-transparency view screen.

After refamiliarization training, the remaining time is given over entirely to mission simulations. There are tough simulated emergencies programmed by the instructors at unannounced times, one of which requires a simulated service call to the main nuclear reactor in the tail.

Module arrangement of SS Alpha -

All modules, M1 through M5, are connected end-to-end in numerical order to form a regular pentagon which is the life ring. The floor of each module is at the outer side of the life ring. Since the ship has rotational symmetry there is no left ship side or right ship side and no global up or down. The “port-to-starboard” direction refers to moving counterclockwise around the life ring, facing forward.

N1 through N5 are angular nodes connecting the five modules. Node N1 connects module M1 to module M2 and so on.

In the early design phase, some on the design team wanted the main view screen to face rearward to minimize erosion on its outer surface. For a time that seemed like a good idea for another reason as well: interference with the CRT images from the incoming plasma and the outwardly-projected plasma collector beams was a problem, but that was adequately minimized. Another few designers pushed for three eco modules. The quantity two was decided on to meet the allotted budget and to decrease ship mass. Computer modeling showed two eco modules to be adequate for a crew of 12. They would be capable of supplying a closed ecology for as long as there was energy to power the modules. The life ring balances with six in M1, four in M2, and one each in M4 & M5.

The mission begins -

Your training complete, you depart to the surface for R&R and final briefings while the drydock crew maneuvers the nuclear propulsion unit into place. The large solar-cell array which had been providing electrical power to the life ring will be of little use in interstellar space, and is removed.

The dry-dock crew mates the larger open forward end of the NPU funnel to the aft open face of the life ring; its smaller remote aft end carries the nuclear reactor terminating in the main jet engine. Previously, maneuvering rockets, tanks, and payload were attached around the outside of the funnel. Spacesuits and other gear are now stowed in the intermodule nodes of the life ring.

Mating is complete. The NPU funnel systems are checked, the reactor brought on-line, and the main engine is given a simulated run by the dry-dock crew. Auxiliary fuel, propellant, and oxygen tanks are filled. Water and other supplies are replenished. SS Alpha is now fully assembled, provisioned and fueled, its biosphere primed and operating to maintain the required closed ecosystem. All flight crew are brought on board and the ship is ready to head out.

Three space tugs move into position, attach lines to nodes 1, 3, and 5, and prepare to ease the big ship free of earth orbit and slingshot it into solar orbit. The tugs accelerate, pulling the ship after them. After release, artificial gravity is re-established.

SS Alpha's new path inserts her into a near circular atmosphere-grazing Jupiter orbit, enabling the propellant tanks to be topped off with the methane and ammonia gases that are there, and giving the funnel a concentrated gulp of propellant. For the last few orbits the ship accelerates, managing to maintain orbit by directing a component of thrust inwards, toward the planet, like a racecar driver running up the two driving wheels to get a jump on acceleration while holding position by breaking the other two wheels.

Finally the ship breaks free of Jupiter orbit and whips into galactic orbit, setting sail for its designated spot in interstellar space. You expect to be back at Jupiter in eight years.

Initially, propellant is drawn from the tanks; but rapidly the engine becomes more-and-more self-sufficient, collecting larger-and-larger

amounts of hydrogen and other ions from the tenuous atmosphere of space until the ramjet finally “bites.” The main engine is now totally self-sustaining at which time some of the collected propellant begins flowing into the tanks, soon refilling them. A steady acceleration of $\frac{1}{4}G$ is maintained from this point.

SS Alpha’s tanks are now filled to capacity, and remain full during the outbound leg of the voyage. That stored propellant will be needed to start you headed homeward from the turn-around point, four years down the road - or sooner if the mission must be aborted.

The four-year voyage outward -

You’re now well on your way to *Alpha Centauri Waypoint 1*, nicknamed *San Salvador*. You’ve settled down to the daily routine and ease back to enjoy the view. Through a rear viewport you watch the sun recede. Watching long enough and often enough you imagine you can actually see it in the process of shrinking. You wonder: would Einstein say it is really shrinking? It certainly appears to be. Of course you’re being silly; but in your musings you wonder about the reality of the relativistic foreshortening. You know that Einstein - gone 80-some years now - based his famous conclusion of an impenetrable light barrier on the supposed reality of that foreshortening. But what if it’s only an appearance like the shrinking sun you now see? You make a mental note to read his 1922 book, *Sidelights on Relativity*, that the captain recommended; especially pages 35 & 36 where he admitted he was previously wrong, with the strong implication that the light barrier may not be absolute.

In any case there’ll be no attempt to exceed lightspeed this time out. The prevailing view remains that it cannot be done, and until convincing evidence to the contrary is found, it is probable that no attempt will be made to do it.

You remember reading that in the ship’s bulletin last evening. Maybe you’ll gather evidence and the next mission can attempt it. Anyway you’re already accelerating as hard as the laws of physics allow this particular ship to do, and any attempt to exceed lightspeed this time

out would simply extend the journey, already programmed at eight years round trip.

You punch up the daily newscast from home. Of course it's delayed but you have adjusted to that with no difficulty. Anyway, it seems to be the same, day after day, with continuing reports of escalation of bitter ethnic/religious wars as the different groups scramble for domination, and rampant worldwide terrorism interspersed with reports of earthquakes, floods, volcano eruptions, Katrina-class hurricanes, tsunamis and fires. And now on top of it all, there are growing demands for official recognition of interspecies marriage.

Harley, who is watching with you, quips, "Now when you kick your dog you could be arrested for spousal abuse!" You both laugh uncomfortably.

You add, "But only if Fido decides to press charges!" Uproarious, uncontrollable laughter.

There seems to be a headlong rush back home to end civilization. Harley says it's because there are too many people too close together. You pray that efforts to reach new shores for Human settlement pay off soon. You recall that Rodney King had asked, "Can we all get along?" ...A simple question, yet an elegant and forceful one.

This more-recent quotation from President Biden also comes to mind:

Any species, in order to assure their long-term survival, must continually strive to go beyond where it now is.

...A powerful call for cooperation and collaboration.

Was it Poul Anderson who, in a cynical pun, referred to the *planet of Terra* as "The Planet of Terror"?

Before turning in, you go to the rec room to enjoy an episode of Irwin Allen's "Lost in Space" with other off-duty souls on the big screen. "What a blast!" you think. Especially Dr. Smith and the way he weasel-words himself into, then out of some tight situation or other. "Marvelous!" you verbalize and the others respond with "Shhh." Next week the program calls for George Pal's 1950 Oscar-winning adventure,

“Destination Moon” written by Robert A. Heinlein. A real classic and a must-see.

You look forward to these Fridays when you can get with your circle of close friends informally.

Later lying in your bunk, you resolve to start hitting the books with an eye to taking your masters exam before the trip is over. Thinking those thoughts, along with writing letters home, helps you keep your sanity. Even though the answers to your letters are delayed, it doesn't matter and you feel that each was written only the day before.

You give thanks for the duty periods as they keep your body and mind occupied. But during off-duty hours, melancholy sometimes sets in. Looking out the viewport doesn't help anymore, and indeed makes it worse, for it gives the distinct feeling that the ship is stuck in some infinite vat of star-studded black molasses. Except for the monotonous *quotidian rotation* of the sky due to the ship's slow rotation as you bore through that molasses, you sense no motion; you see no change in the star patterns. When you've had enough of that feeling, you call up the ship's realtime spectrographic display for confirmation that you are, indeed, still moving.

Are we there yet? -

You're nearly halfway there. Old sol is now just a point of light - a star among stars. The ship has been accelerating steadily away from the sun since departing Jupiter, but soon that will turn into a steady deceleration. The ship will not physically turn around until it is time to head back home because the funnel must continue facing forward along the flight path to harvest hydrogen. The impending retroburn phase thus means reversal of thrust and reversal also of the resulting on-board gravitational bias. You look forward to this new event, a period of readjustment, to break the monotony.

Your steady acceleration during the trip has been $\frac{1}{4}G$, and to return the gravity vector closer to normal, the ship rotation is set to provide a total gravity of $\frac{1}{2}G$. When you walk down the corridor you now list 12° metric to one side; you'll soon have to adjust to an opposite list. [12° metric (12° “degrees centigrade”) is $12/100$ of a semicircle or 21.6 Babylonian degrees - Ed.]

San Salvador ho! -

It's now 2045. As you approach the chosen point in space as confirmed by the global star patterns, the impulse engines grind the ship to a halt - the condition where all spectrographic sensors indicate there is no average motion among the stars. It is at this point - nearly $\frac{1}{4}$ of the way to Alpha Centauri - that ISAA, Interstellar Spacebuoy Alpha-Alpha, is to be deployed. For the deployment, three crew must engage in a space walk. You are among them. Your duties include video documentation of this historic event for immediate relay home.

After deployment, ISAA's on-board sensors and vernier jets act to maintain it in a station-keeping galactic orbit for scores of years, perhaps even centuries. Its pulsating radio and laser beacons announce to the universe, "I am here." The casual astronomer on an uncharted world may, if he takes note of it at all, catalog it as just another pulsating stellar object. But if he looks long and hard, he may see it as an artifact of an intelligent species and a clear sign that someone has staked claim to a point in interstellar space; someone to be reckoned with; someone calling themselves *Humans*. Just the thought makes you look around to see if somebody else's spacebuoy is nearby!

ISAA is now deployed and so is officially renamed "San Salvador Station". She is in position and operating normally. Humans have left their mark. The Milky Way galaxy has a new star and the time has come to leave this place.

Heading homeward -

The vernier jets turn the ship towards home. The initial acceleration phase will be crucial, as there can be no harvestation of interstellar hydrogen until the threshold ramjet speed is reached - about 0.01% of the speed of light. To arrive at that happy state of affairs depends on the modest initial acceleration provided by the limited amount of tanked propellant and the maneuvering rockets.

But finally the ramjet bites again, and SS Alpha is back in her natural environment - sailing along at a constant $\frac{1}{4}G$ acceleration through interstellar space which soon moves you at a respectable fraction of the speed of light towards home. In two years the deceleration halfway point

is reached once again, and from that point another two years brings you to an orbiting stop at Jupiter. There is now a blossoming starport abuilding there, and you are home by interstellar standards. SS Beta is there, preparing to leave on her own pioneering interstellar journey, and cadets are all over you and your crewmates with questions when you arrive.

But the first starship will not end her journey at Jupiter; the plan is to park it in permanent orbit around the moon, in an extension of the Smithsonian Institution in a place of honor “alongside” the Wright Brothers’ *Flyer*, Lindberg’s *Spirit of St. Louis*, and the *Apollo* moonship. ...*The Friggin’ Buzzard*, the original, right here; the life-blood of a cosmic species!

Welcome home starman!

The sun looms large. You’d forgotten how large.

The artificial gravity had been gradually increased during these final weeks until you are at 85 percent of earth-normal gravity; thus you will have little difficulty regaining your land legs when you finally step out onto terra firma.

You recall the story of the twin paradox and wonder: “Will all my friends have aged more than me?” Maybe some have even been dead for years. But no; you’ve kept up with the obituaries and you know that hasn’t happened. And you’ve been informed of the current earth date and time.

The newscasts from earth which you had been following almost daily during the trip are now up to date. Yes, you come home fully informed and educated on all that has happened since you left, eight-plus years ago. You know that a respectable space infrastructure has grown up on and around the moon and the earth while you were gone, and that - in addition to the now-abuilding *Jupiter Base* - the first permanent Mars settlement, *Utopia*, is nearing completion. You suppose that this impressive progress can be partly attributed to the inspiration provided by the success of “the friggin’ buzzard” reported daily in the local news, and to the Priestley oxygen generators that have sprouted-up all across Mars. And the technology developed from all these efforts dealing with life-

support needs has led to significant improvements in the quality of life on earth too. Life is good.

Home and Family -

The year is 2049. The ship inserts into lunar parking orbit.

You are next transported to *Moon Base Armstrong* at Mare Tranquility with the entire crew for debriefing and you see and talk with mom and dad by high resolution video link. You hear “our boy,” bringing you down a notch. (*High resolution* TV, as opposed to the abortive incompatible “high definition” turn-of-the-century experiment, is a system fully compatible with 1950s American NTSC over-the-air television standards. It incorporates new cameras capable of sensing Helmholtzian full gamut color.

The Twin Paradox

You and Harley discussed relativity every chance you got. There was a time when the subject was the twin paradox. You had started that conversation:

You: “Harl, you’re an expert on the twins paradox, AKA Einstein’s clock hypothesis. What do you think Einstein meant when he said that a clock at the earth’s equator runs slower than a clock at one of the poles, by a very small amount? I mean, since the two clocks are not side-by-side, how can you even make such a comparison?”

Harley: “You mean where he wrote in his 1905 landmark paper, ‘Zur Elektrodynamik bewegter Körper’,

Man schliesst daraus, dass eine am Erdäquator befindliche Unruhuhr um einen sehr kleinen Betrage langsamer laufen muss als eine genau gleich beschaffene, sonst gleichen Bedingungen unterworfen, an einem Erdpole befindlich Uhr.

...Is that what you refer to Norm?”

You: “Yeh, that’s it” you reply in good humor, remembering that Harley’s last name is Schmidt.

Harley: “That’s bothered me too. It seems people took that to mean that the different speeds at which the clocks are moving is to blame; but maybe Einstein meant that the different gravity forces are to blame, with the ‘Uhr’ (clock) at the ‘Erdaquator’ being subject to a lesser gravity because of the centrifugal force from the earth’s rotation that the clock at the ‘Erdpole’ doesn’t feel.

“And here’s a really transparent scenario for you to ponder, Norm. Say twins Dexter and Levulor head away from the earth in rightward and leftward directions in a totally symmetrical, mirror-image way, out and back, with the same acceleration profiles. When they return to sit side-

by-side, their clock indications and their agings cannot differ as a result of any relativistic effect, simply because of the total symmetry in their speed and acceleration profiles. Of course this says nothing about how their two times compare to the time of those who stayed behind. But if that scenario is then repeated so Dexter travels out and back at a constant 1G acceleration all the way, but Levulor stays at home under the constant 1G field of the earth, how will the final result differ from the first scenario?"

You: "Yeh, Harl. But what about the speeds? Only Dexter is traveling in the second scenario."

Harley: "Sure Norm. ...with respect to Earth, you mean. But anyway, each sees the speed of the other relative to himself in a totally symmetrical way - Dexter sees the Earth as moving away. Speed is relative, not absolute as acceleration is - except for photons themselves of course. So that's no problem."

You: "And since acceleration and gravitation fields are equivalent under general relativity, that means speed and acceleration/ gravitation profiles are once again the same for both twins; so Dexter and his twin sister Levulor should both age the same this time too!"

Harley: "Right! ...Why do you think Levulor is a girl, Norm?"

You: "Why do you think she's not? Anyway, whoever heard of a guy named Levulor. ...But if Dexter uses some funky acceleration profile, then the general theory would intervene - in a way that depends on the specific profile - to possibly give a nonzero aging differential, positive or negative. But that wouldn't be velocity dependent; it would depend strictly on acceleration."

Then you and the rest of the crew of the just-returned first starship are transported directly from Tranquility Moonbase to *Earth Station Goddard* and taken from there to the surface by a new generation of high-apogee shuttle. You land at Edwards AFB, fly to D-M AFB at Tucson, and receive a final end-of-mission debriefing followed by a battery of medical debriefings at the Kino Campus of the University of Arizona Medical Center, part of the *John McCain Southern Arizona Starport Corridor* where *Starbase PCC-EC/UA-South Academy* is located with its latest crop of cadets. You will stay over a few days at the *Janet Napolitano Guest House* to address the new kids at the Academy. You'll remind them that the ancient Chinese proverb, "The nail that protrudes gets pounded down," is here replaced by

At Pima, *Nails* are expected to protrude!

To emphasize that expectation, plebes are called *Nails* here.

When a student interrupts in class, instead of mumbling something like, "Excuse me, professor, for intruding," he/she will stand and shout

"Professor! [Waiting to be recognized.]

"Excuse me for protruding; (but) I have an important question!"

All questions in class are important, by definition.

Recognition consists of the professor responding with "Yes, ..." with the student supplying his/her name if the professor does not, as in **"Ruby! Sir!"**

Then, "What is your question, Nail Ruby?" ...

PCC-EC/UA-South in Tucson is bracketed by East Stella Road on the north and the D-M Aircraft Boneyard to the South. Santa Rita High, which is within walking distance of the Academy, is the entry point to the Academy for new high-school graduates. This complex is at the north edge of the John McCain Starport Corridor which runs the full east-to-west width of the State of Arizona.

There is a giant arch along Interstate 10 across the Santa Cruz river with a branch of the Flandreau Planetarium right there along with other attractions. That was planned in 2005. So Southern Arizona was already planning in 2005 for the Starbase PCC-EC Academy without realizing it.

Those just entering the Academy may be intrigued by a Star Pass address where new housing is going up. Star Pass Golf Course is nearby. Star Pass is in the Tucson Mountains near the West Campus of Pima Community College. You make a mental note to contact Brumbaugh at his Star Pass address whose great granddad used to work with your great Uncle Homer in that area at Sensory Systems Laboratory.

Thinking back, you recall that your great Uncle Homer liked to tell of the time in 1960 while still with RCA Service Company in Van Nuys California, when he and fellow engineer Art Tapper after flying to San Diego on a Company Gulfstream jet, paid a familiarization visit to Convair where the Atlas launch vehicle was being manufactured, and how he happened to run into the original seven astronauts in the cafeteria there: Scott Carpenter, Gordon “Gordo” Cooper (the youngest), John Herschel Glenn (the oldest), Virgil (Gus) Grissom, Walter Schirra, Alan Shepard, and Donald “Deke” Slayton. They were all there. President John “Jack” Fitzgerald Kennedy wouldn’t set the goal of going to the moon for another year, and the first moon landing wouldn’t happen for another eight years after that - on 20 July 1969. Exciting stuff!

In Mercury/Redstone 4, Gus Grissom (in panic mode, some said) prematurely popped the hatch on his capsule, Liberty Bell, on splashdown flooding the interior. In Mercury/Atlas-8, Wally Schirra forgot to turn on the TV camera in his capsule, Σ -7, Afterwards some would jab, “Hey Schirra, Schirra, / What happened to the TV? / The picture’s not ours to see. / Hey Schirra, Schirra. / Where is the TV?” (Sing to the tune of “Que sera, sera.”)

Uncle Homer was born in 1926 making him younger than both Deke Slayton (b.1924) and John Glenn (b.1922). He'd washed out of Navy V-12 pilot training in 1944 during WWII due to reduced vision in one eye. Otherwise he might have become an astronaut himself, or so he liked to say.

His epitaph reads in anticipation, "Starbase PCC-EC would happen naturally when the GX showed that star travel is practicable." He was that confident that the Grand Experiment was based on sound science compatible with relativity, and that it would work.

You are now only 30-something, having left when you were 22. On the way to the debriefing you muse: If someone asks me if I'd do it again, I'd answer, "In a heartbeat! Just give me two weeks. ...But we really need three bio-modules so everybody can eat better." However, after you spot Julie you may change your mind about heading out again so soon.

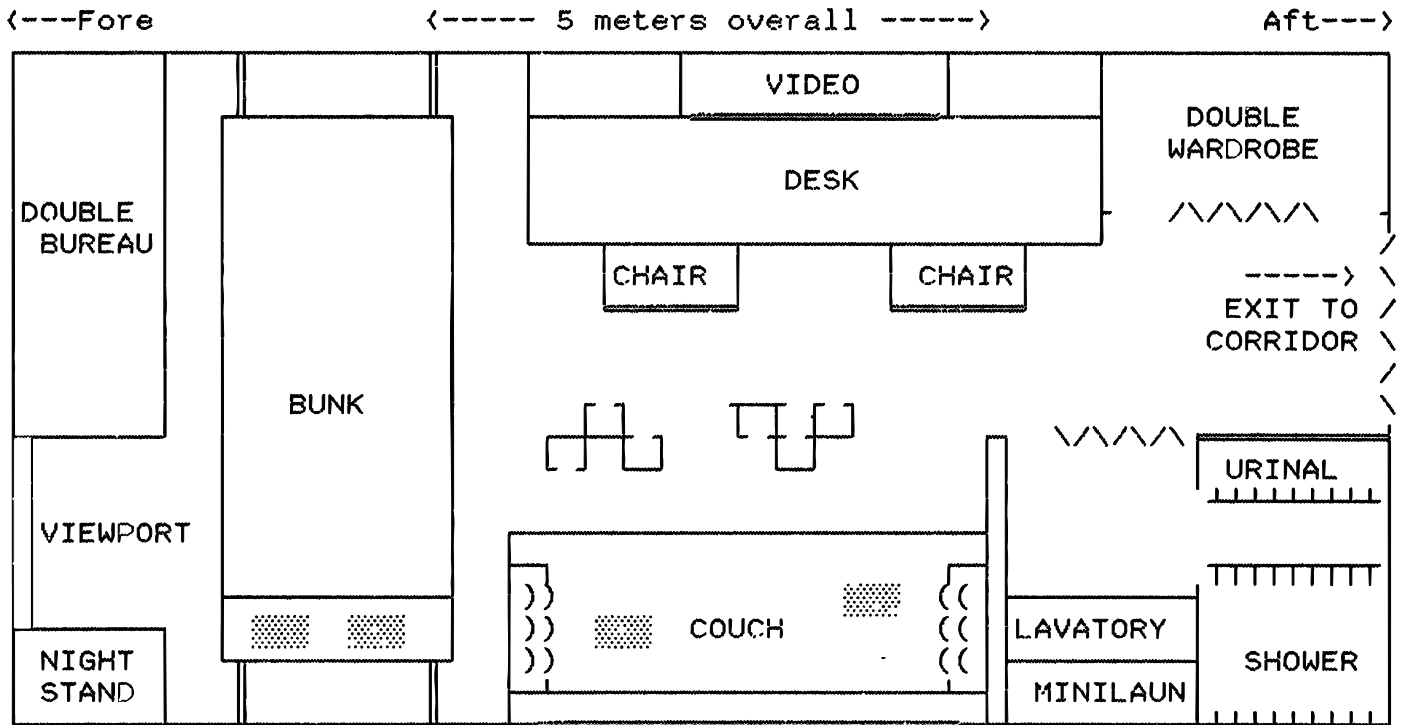
It shouldn't have come as a surprise to learn that earth clocks are almost half an hour behind the ship's. The reason, you are told, is that while you were in space experiencing an average gravitation field of just under $\frac{1}{2}G$ for eight-plus years, those who stayed behind were immersed in a full 1G field. Thus for eight years, atomic clocks on the ship ran faster than clocks on earth in accordance with the general theory of relativity. It turned out that the opposite effect, which some had predicted from special relativity, did not materialize. Harley had it about right. (See Plate II.) You wonder if this new information will be enough to justify an attempt to break the light barrier next time out. You remember the television movie, *Longitude*, and think: *John Harrison, where are you when we need you?* We need a new space clock.

You're anticipating being home with your family once again. But you'll find that the toughest part of the journey lies ahead for you and your eleven crewmates, with ticker-tape parades followed by weeks of guest spots and interviews - not to mention the extensive interviews, conferences, and speaking tours. The excitement is electric; the world has been following your epic journey all the way and it is now time for you and the rest of the crew of *the first starship* to acknowledge the world.

Appendix

Preliminary plans for SS Alpha

Floorplan, typical stateroom, M2 module. This plan is used for Altair & Centauri Suites; opposite-handed plan is used for Milky Way & Jupiter Suites. It is also used for dormitory rooms at the Academy.

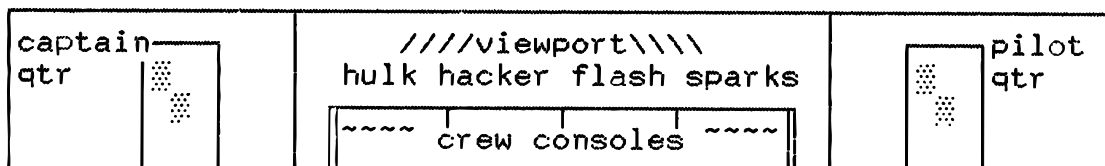


One bunk. In case of an overlap in off-shift hours, the 175-cm-long couch can double as a second bunk.

Elevation views looking forward (Not to Scale) -

M1 - Central control

connects
to M5
via N5

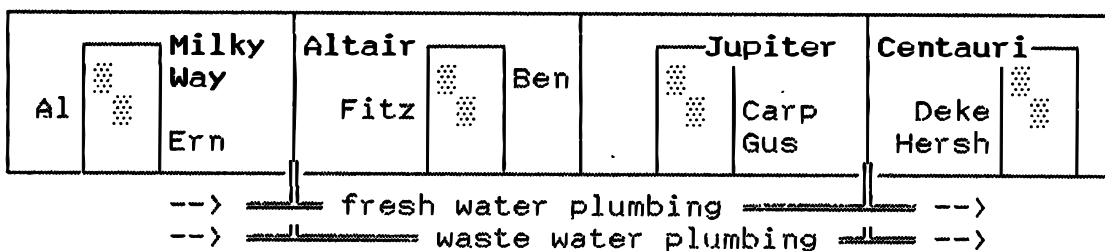


connects
to M2
via N1

Captain's and Pilot's chairs (not shown) are aft of the four crew consoles.

M2 - Crew quarters

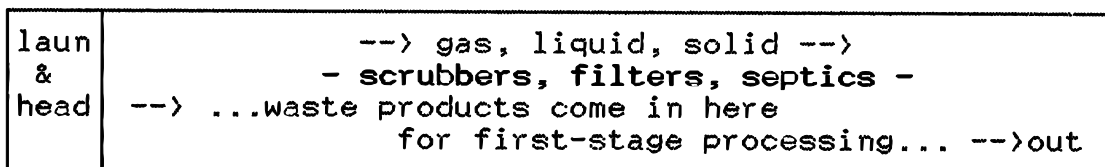
connects
to M1
via N1



connects
to M3
via N2

M3 - Biosphere A

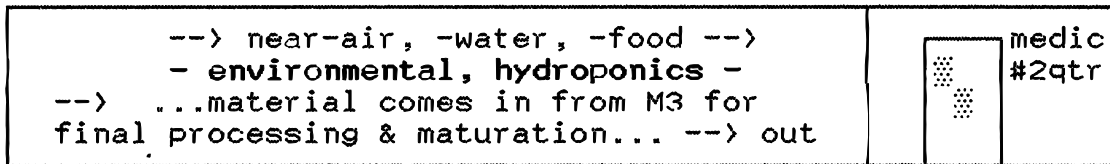
connects
to M2
via N2



connects
to M4
via N3

M4 - Biosphere B

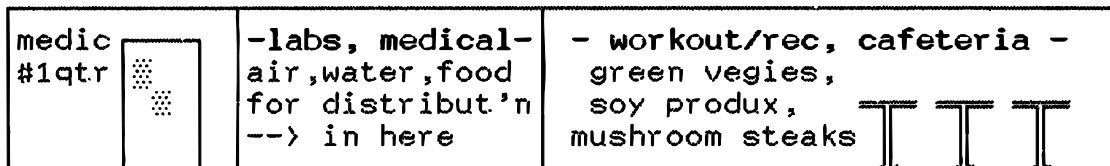
connects
to M3
via N3



connects
to M5
via N4

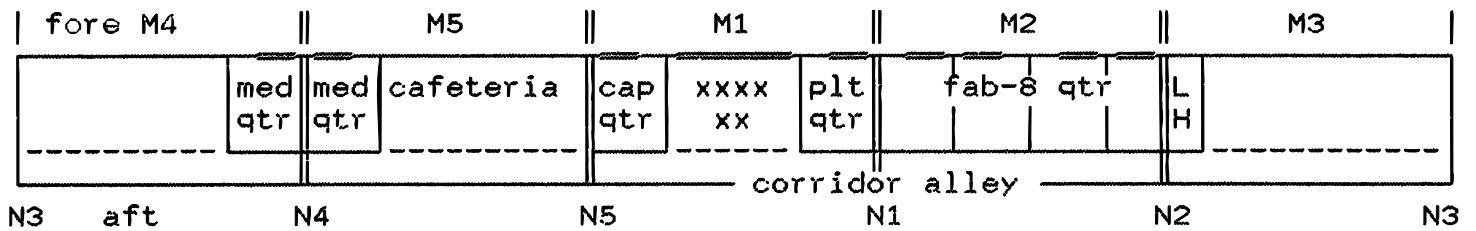
M5 - Life needs

connects
to M4
via N4



connects
to M1
via N5

LR-1 unrolled plan view (suppressed nodes at ||)



Shift Assignments - 24-hour days - eight shifts (Sf.1 thru Sf.8).
 Each crewman 12 hours on, 12 hours off.
 Shift changes occur at three-hour intervals.

	Shift start time							
Crewmember	0000	0300	0600	0900	1200	1500	1800	2100
Pseudonym	<u>Sf .1</u>	<u>Sf .2</u>	<u>Sf .3</u>	<u>Sf .4</u>	<u>Sf .5</u>	<u>Sf .6</u>	<u>Sf .7</u>	<u>Sf .8</u>
Al (Alan)	C1	C1	C1	C1	--	--	--	--
Ben	--	C2	C2	C2	C2	--	--	--
Carp	--	--	C3	C3	C3	C3	--	--
Deke	--	--	--	C4	C4	C4	C4	--
Ern (Wally)	--	--	--	--	C1	C1	C1	C1
Fitz	C2	--	--	--	--	C2	C2	C2
Gus (Gordo)	C3	C3	--	--	--	--	C3	C3
Hersh	C4	C4	C4	--	--	--	--	C4

C1 is *Hulk*, C2 is *Hacker*, C3 is *Flash*, and C4 is *Sparks* console.

Every four biweeks (about every two months) pseudonyms can be rotated or chosen by lottery among the crew to provide variety in shift hours and quarters - like a vacation and moving day rolled into one!

Chapter 8

The Phase Two Experiment: Alpha Centauri or Bust!

With the Essential Observer being anyone on the ship, the Balance of Forces Equation, eq.(1), for the rocketship/ jetship reduces to $F=m_o\alpha$ bringing us right back to a pre-Einsteinian treatment of the problem. Additionally, under the kinematical perspective view, time dilation resulting from the special theory of relativity is only an appearance not producing a permanent “set” in time. And the general-relativity component of time dilation can be nullified by maintaining a continual 1 G acceleration. Thus when our travelers return home, age will not be a problem.

A preliminary analysis of the results of the Phase 1 experiment strongly indicate that our ships can “poke through” the light barrier.

BULLETIN

Volunteers Being Recruited

As one of the first four ambassadors to Alpha Centauri, you will ride along and place two *Embassy class surveyor satellites* in orbit around sun *G4* of that star pair, then return to Earth. Married couples are encouraged to apply. You will go down in history as one of the *first Humans ever* to live in two different solar systems. Apply at alphaCentauri.exe.

It's now 2049.

Got 50 gigabucks to invest and eight years for an exciting, fun-filled vacation away from home? The remaining start-up costs are to be picked up mostly by assorted sponsors and a far-seeing media mogul. NASA wanted to oversee, but Congress insisted on placing too many restrictions. Then when top-notch NASA engineers began defecting to *The Consortium*, Congress relented some and NASA was welcomed as an active participant.

As part of the on-going development, the sponsors and media would find ways to use marketing and gee-whiz docudramas to make this effort pay for itself from even before it got started. Almost, anyway.

Your mom wishes you'd get the idea of actually going to the stars out of your head, saying, "Interesting, but I wouldn't want to go there. I figured we'd go someday, but never thought it would be my son!"

An extreme ride -

Following Project Apollo, the dream of star travel was kept alive through marvelous stories; but those stories were mostly fantasy and it seemed that little was being done to make it happen. The International Space Station was never fully completed, efforts being siphoned off to establish a staging base on the Moon - a jumping-off place to Mars and beyond. Mars was being probed left and right. This is future history being formed.

Hard on the heels of the establishment of the first Mars base in 2020, development of the first manned starship to test new hardware and concepts was begun. Thanks to an intensive effort, a Bussard interstellar jetship was fashioned; and in 2041 *Starship Alpha*, "Friggin' Buzzard," was launched with a 12-man crew to place marker buoy *San Salvador* at a place ¼-way to Alpha Centauri. As President Kennedy had said about going to the Moon, "Not because it is easy but because it is hard."

Midway through that eight-year trip, star travel began looking more & more realistic to people around the world. The development of a deep-space infrastructure accelerated with *Jupiter Station* as its centerpiece. It

became increasingly apparent that it *could* happen, and that this is the way it *would* happen. The Japanese, Chinese, Indians, Europeans, Russians and Americans all wanted to be first to reach another star; and a healthy, fierce competition developed. The continuing effort coalesced into two major competing camps: *Eastern* and *Western*.

As optimism and excitement grew, the time-to-launch of the *Suzue* was compressed from early projections so that in a gigantic orgasmic eruption we now find ourselves on the first ‘manned voyage to another star; the second ‘manned star trip ever. This is not another voyage like Columbus’; it is more akin to the emergence of life from the primordial swamp onto dry land; it marks the beginning of a *cosmic migration*.

Born again -

German physicist Max Born wrote a book called *Einstein’s Theory of Relativity* in 1920 which was translated into English in 1924, and he wrote a revision of that translation in 1962. A quotation is given here from the 1962 edition (Dover, pp. 258-60):

Imagine a journey to α -Centauri. ... These space experiments cannot at present be performed. But there are phenomena due to small cosmic particles [π -mesons] which can be observed and used for a perfectly convincing confirmation of the time dilation and the effect described in the clock paradox. ... If the velocity of the cosmic mesons [with lifetime 10^{-8} s] were as large as that of light, the distance traveled by them would be only $cT_0 = 3 \times 10^{10} \times 10^{-8} = 300$ cm. But π -mesons of very high energy are observed on sea level. How is it possible that they penetrate the atmosphere, traveling a distance of about $h=30$ km during their lifetime? This [π -meson paradox] is resolved by taking into account the dilation of time.

The π -meson paradox just described does not require use of the clock paradox of special relativity for its resolution; it can be resolved by applying general relativity. As the π -meson strikes the Earth’s atmosphere and travels through it, it would experience a strong negative acceleration. By the general theory, that acceleration field would slow the decay of the particle. Viewing the process under the Maxwell-Schelkunoff analog, the speed of light is reduced in a strong acceleration/gravitation field, resulting in the slowing of atomic processes. And of that there is no doubt from this quarter.

In a first approximation, a constant drop in speed of the π -meson might be assumed, going from c to zero over the distance of 30km. The elapsed time would then be $t = 60/c$ s, and the acceleration $a = -c^2/60$ km/s² where $c = 3 \times 10^5$ km/s. That is a strong acceleration field on the order of 10^{11} G (recall that 1 G is 9.81 m/s²), which would no doubt cause a significant slowing of the decay process. A more-detailed and precise calculation would now be in order.

Onward and upward! -

Our fictitious hero, David, born in 2026, will be 24 when he begins training in 2050 for his trip as captain of the first ship to Alpha Centauri, 43 when he leaves, and 51 when he returns to Earth. ...He, along with an engineer/navigator and two medical/ life-support types. All four crew are heavily cross trained. The four passenger/ambassadors are well versed in procedures as well, and so we have effectively eight crew members.

Nearly two centuries of flight are chronicled and projected:

- 1903 Wilbur & Orville Wright achieve powered flight
- 1947 Chuck Yager breaks the sound barrier in the Bell X1, while some are still saying that the sound barrier cannot be broken
- 1960 Robert Bussard conceives of the interstellar ramjet
- 1961 May 25th: President #35 (John F. Kennedy) sets a goal of a manned moon landing and return before the end of the decade
- 1969 July 20th: Humans (Neil Armstrong & Buzz Aldrin) set boot on Moon (Huma 3B) at *Tranquility Base* in project Apollo
- 1972 First soft-landing of a probe on Mars
- 2004 January: President #43 (George W. Bush) redirects space program towards Moon & Mars
- 2004 *Spirit* roves around Mars at *Columbia Memorial Station*; *Opportunity* roves around Mars on t'other side
- 2005 The Planetary Society attempts to launch Cosmos I sailing ship towards Mars but the attempt fails
- 2007 Phoenix Mars explorer launched by the University of Arizona. Preliminary plans drawn up for the *John McCain Southern Arizona Starport Corridor*
- 2010 Work begins on Bussard interstellar ramjet engine

- 2015 Humans return to the Moon
- 2017 Cosmos II sailing ship launched towards α -Centauri
- 2022 First Humans set boot on Mars at *Utopia Base*
- 2041 Starship Alpha launched, powered by Bussard ramjet
- 2045 Spacebuoy *San Salvador* placed $\frac{1}{4}$ -way to α -Centauri
- 2046 Jupiter Station dedicated
- 2049 Starship Alpha arrives back at Jupiter Station with all 12 crew/hands safely on-board, time differential is shown to be small and without consequence
- 2049 President #50 redirects space program to α -Centauri
- 2050 Crew training begins for trip to α -Centauri
- 2069 Starship Suzue leaves Jupiter Station for α -Centauri
- 2070 Humans break the light barrier, while some are still saying that the light barrier cannot be broken
- 2070 Tests begin of superluminary comm links
- 2073 Humans reach α -Centauri, place two embassies in orbit; Humanity now owns those two parcels of Centaurian territory, without objection from any indigenous intelligent society
- 2077 Starship Suzue arrives back at Jupiter Station with all eight hands safely on-board - the four crew and the four ambassadors have been temporarily recalled home, and it is seen that time is “off” only marginally
- 2078 President #55 announces Megalopolis initiative in his January State of the Union message
- 2078 In view of the impending arrival at β -Centauri in ten years of Marconi’s original radio signal, *The Planetary Society* pushes hard for a probe to get there first

A science experiment -

Stonehenge; crop circles; Area 51; once-a-day gamma-ray bursts from seemingly everywhere in the universe; SETI taken seriously; discovery of more and more extrasolar planets; exobiology as a legitimate science - and that’s only up to the year 2005! If we were feeling like penned-up geldings in a galaxy of free-roaming stallions, that feeling began to subside under the kinematical perspective view of special relativity.

In addition to the 20th-century variety of crop circles in fields of grain, there were now rumors that such images had been spotted on expansive desert sands and fleetingly on the waters of large lakes.

“Ladies and gentlemen this is your Captain speaking. Happy New Year twenty sixty-nine, the 100th anniversary of the first manned moon landing, and welcome aboard the *Suzue*, a Lockheed Martin New Constellation powered by General Electric SJ-32 interstellar jet engines. Through a forward viewport you may be able to see a robotic sailing vessel, *Cosmos II*, by the occasional reflection of starlight from its gigantic sail. It’s that faint, out-of-place ‘star’, there, now part of the constellation Scorpius. It was launched 50 years ago by The Planetary Society with the same destination as ours. We’ll reach our destination and be back on Earth before *Cosmos II* can reach San Salvador, the quarter-way point.

“Our voyage to Alpha Centauri will take 49 months, about 212 weeks, and we’re projected to reach a top speed more than twice normal lightspeed. Whatever happens, we are programmed to turn around and head back home before we have been out 50 months. If everything works out as planned, when we get back home your family and friends who stayed behind will have aged the same amount as you.”

Captain David Gallegher continues, “Sit back and enjoy the flight. After we are fully spaceborne, you will be free to go about your business in a shirtsleeve environment under normal Earth gravity. E-mail links will remain open and usable for another few months. We will also be testing a new superluminary comm link for which volunteer experimenters are being recruited. I, along with the crew, look forward to meeting with each of you later in the cafeteria. Have a nice flight.”

The *Suzue* is like a mini earth-sun system; self-contained, self-powered and self-regenerating; free to go as fast as its 1.1 G acceleration capability will take it, virtually anywhere there is interstellar plasma to swim through, for as long as its nuclear power plant is operational and its integrity can be maintained.

At dinner this evening, Ambassador Fergie turns to you between bites of a tasty mushroom steak and says, “My grandmother used to tell of crossing the Atlantic Ocean around the turn of the century from London to New York and back in the same day on the Concorde. ...And, on the westbound leg, she’d tell how the sun would actually appear to be moving from west to east - as if time were running backwards. ...There’s your ‘time travel’ so many stories have been written about! And they’re still writing them! ...Anyway, she would tell us kids how exciting it was just to know you were really traveling ‘twice as fast as the speed of sound’ as she put it.

“Well, here I am [voice quavering, pausing, fork poised in mid-air]. In a few months we’ll really be traveling twice as fast as the speed of light. How awesome is that! ...And what bizarre sights must await us! Will the stars all vanish? ...Maybe new ones will appear!!”

Epilog -

Upon your return to Earth, there are two new souls aboard; an Adam and an Eve, perhaps. Two first ever Centaurians born of Humans within the territorial space of Alpha Centauri. There is now and will forever be this Human connection with Centaurians - between the Huma system and the Centauri system. Is this the way the life component of the Universe is to evolve and develop?

Glossary -

Human	someone native to the Huma system
Centaurian	someone native to the Centauri system
Huma system	the solar system that contains the planet Earth
Centauri system	the solar system whose sun is Alpha Centauri G4
someone (provisional)	a bipedal primate mammal (<i>homo sapiens</i>)

Appendix 8A

Communication

Captain Gallegher spoke of a “new superluminary comm link.”
How can there be such a thing?

Ship-to-shore communication has to do with sending and receiving *information*; and as the pioneering cyberneticist Norbert Wiener wrote in 1948, “Information is not matter or energy. Information is information.” Backing that up is a 1996 finding by Roll Landauer of the IBM Thomas J. Watson Research Center in Yorktown Heights, New York, in which he found that there is no minimum energy requirement for sending information. Landauer’s original announcement appeared in the June 28, 1996 issue of *Science*. He suggested methods that might be used to send information without dissipating energy.

It was suggested to this writer (Tilton) in 1966 by associate Richard Gerdes that an energy beam, once established between two remote places, might be used as a carrier for faster-than-light communication. In keeping with that idea, a unique method of sending information at more than twice the speed of light was proposed by this writer in the *Journal of The British Interplanetary Society*, “Superresonance and Interplanetary Communications,” Vol. 50, pp. 159-160, 1997.

The point is, the speed of transmission of information is not, in principal, subject to considerations of the speed of light because information is neither matter nor energy. Therefore there certainly is hope of communicating at super- or even hyper-lightspeeds without conflicting with relativity.

Appendix 8B

The John McCain Southern Arizona Starport Corridor

Coming under the Federal Oversight of the *National Ports & Harbors Authority*, the *John McCain Starport Corridor* would run across the full width of Southern Arizona just north of the international border with Mexico, with a suitable buffer zone being surveyed-in and fully covered by an intruder-alarm sensor grid. The Starport would have no star launch facilities of its own (those would reside in space primarily in Earth orbit in the beginning and at Jupiter Station later on) but would be home to an infrastructure for spaceframe/propulsion development and crew training. ...Those necessary things which were not being met by Houston, Kennedy, Vandenberg and the rest.

That Corridor contains Yuma Test Station at its far west end, then moving eastward, Gila Bend Test Range, Davis-Monthan Air Force Base, and Fort Huachuca. There is Kitt Peak National Observatory, the Mt. Graham Large Binocular Telescope, the Multiple-Mirror Telescope on Mt. Hopkins, the University of Arizona and Pima College where students fresh out of high school would begin learning the ropes & knots of interstellar navigation. Entry level is at the *PCC-EC Star Academy* at Pima Community College, East Campus, and the co-located University of Arizona South. And don't forget Biosphere II, north of there.

Tucson is the main entry point to the Corridor. There's a pregnant industrial capability there, anxious to be nurtured.

As during the time of the Cold War, a way was found to support this increased National effort. It provided good jobs and a firm technological base which helped restore America to technical leadership in the world, a position she had begun to lose in the effluent of the Vietnam-War era and almost totally lost after the Berlin Wall came tumbling down. A 2005 World Economic Forum survey put America at no.10, with Japan and Germany at no.1 & 2 spots.

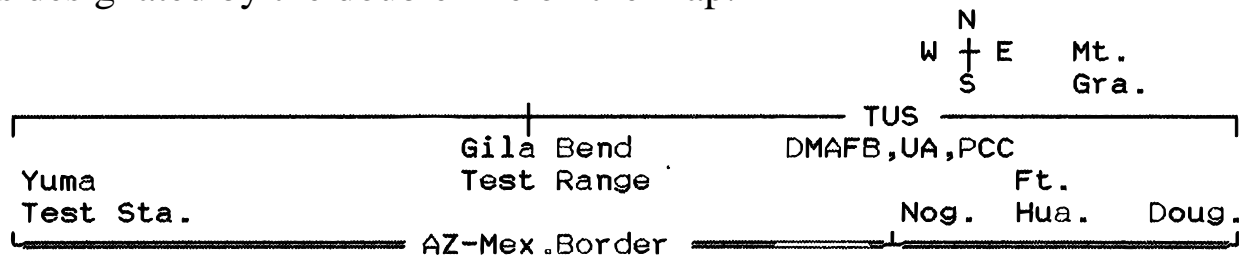
Map of the John McCain Southern Arizona Starport Corridor -

The length of the Corridor is the width of Arizona, 340 miles (approx. 590 km). The southern boundary is the border with Mexico.

Under Plan 1, the northern boundary of the Corridor follows Interstate 10* from New Mexico to its junction with Interstate 8 near Casa Grande, and Interstate 8 westward from there to Yuma Test Station thence along the northern boundary of Yuma Test Station until it connects up with Interstate 8 again, thence to the border with California.

Under Plan 2, the northern boundary of the Corridor is segmented, running from Tucson eastward to the border with New Mexico along the latitude of Tucson (32°13'15"), then from Tucson along a beeline westward to include Gila Bend Test Range, and from there along a beeline to include Yuma Test Station and Yuma Marine Station, terminating at the Colorado River.

Under either plan, the north-to-south width of the Corridor is about 65 miles (about 100 km) at Tucson. The Corridor includes a surveyed two-mile (approx. 3.2-km) buffer zone along the Arizona-Mexico border as designated by the double line on the map.



The northern and southern boundaries of the Corridor are shown straightened on the map, the angled portion of the Arizona-Mexico border running from Nogales (Nog.) to Yuma being shown as if it ran due west; it actually runs at an angle of about 22½ degrees north of due west. Tucson International Airport carries the FAA designation *TUS*. The main campus of the University of Arizona is located at Tucson as are Davis-Monthan AFB and Starbase PCC-EC Academy. Kitt Peak and Mt. Hopkins are short distances west & south of Tucson respectively, and are both within the Corridor; Mt. Graham is somewhat north of its northern boundary.

* The routes of Interstate 10 and 8 are as of 1 Jan 2000.

FICTION: 2078-

Chapter 9

Voyage to the Center of the Galaxy

Their ships are swift as a bird or a thought.

...Homer

Suzue II, a heavily instrumented unmanned probe of the *Prime Galactic* class, is sent on a round trip towards *Megalopolis* at the center of the Galaxy. *Suzue II* is a two-shape interstellar ramjet. Shape 1 takes her to 10 ℓ t (10X the speed of light). Shape 2 takes her to 100 ℓ t and beyond.

The diameter of the Milky Way Galaxy is given as 100k ℓ • yr and our position as 2/3 of the way outward from the center. An impossibly long way to go? Not at all; not since we've found how to break the light barrier. At 2G acceleration it will take only about 500 years to cover the 33k ℓ • yr distance and return to Jupiter. (Only 32k according to science historian Robert W. Smith, p.137 in *Beyond Earth: Mapping the Universe*, 2002) Or with an acceleration of a little more than 50G, the round trip would take only 100 years.[1]

At those large accelerations atomic processes on the probe will slow significantly, and we might say that ship time slows. Ship time will never stop or run backwards; for it is the acceleration field that causes the ship's atomic clock to slow under general relativity, and for it to stop entirely would require an infinite acceleration giving zero local light speed.[2]

The ship's path is set to lie along the northern face of the Galaxy because the internal galactic cloud is too dense to permit such speeds directly through it safely. Our path, straight through space on a beeline to the center of the galaxy, will be shown to spiral naturally in accordance with the galactic Coriolis effect when mapped onto the galactic disk. Now it is easy to see why Coriolis is called a "pseudoforce."

The nuclear component of the Bussard interstellar ramjet must be certified to operate for the duration of the round trip, whether 500 years or only 100. ...Actually less time than that, taking account of the ship's slowed atomic processes due to its large acceleration. It seems ironic now, recalling that late in the 20th century few could see how an adequate fuel supply could be assured for any kind of star trip to give a continual acceleration even while the long-term problem of the Yucca Mountain nuclear-waste burial site was clear. The nuclear-power solution was the elephant in the living room nobody could see!

Anatole was working the night shift with Tom Kat on the *Megalopolitan Initiative*. He was thinking out loud: "Funny, when you think back to the morass that was the state of relativity in the twentieth century. You know what I mean?"

Tom perks up; "Yeh. ...Whad'ya mean?"

Ana: "I mean...for instance...here you had on one side the twin paradox *yes* crowd, and on the other side an equally vocal group sayin' the twin paradox *no*. The matter went back'n'forth for the whole century. Thoughts and ideas were skewed this way or that by hopes and desires. The *yes* crowd was steadfast. They weren't willin' to risk shootin' down the promise of time travel. You know what I mean?"

Tom: "So what else is new. Isn't that the way it's always been? ...Dreamers versus pragmatists? Shootin'down the twin paradox would have been like shootin'down Santa Claus."

Ana: "I know what you mean. Tell me. Are we better off now? ...I mean knowin' what we know now?"

Tom: [Deliberately] "Now you sound like my mother."

Tom knew what Anatole "Buck" Rogers meant. He dreams of a time when a manned shuttle will be carried aboard a new kind of galactic class ship, to be sent on *Megalopolitan Initiative II*, to begin the trip to the center of the galaxy at an initial acceleration of 2G, then separate from the main ship and return to Earth within the lifetime of its two occupants. He is aware that biological time and atomic time do not distort equally in large acceleration fields as Einstein had assumed they would; and that even though atomic processes slow in a known way, the

way in which the rate of biological processes is affected is still imperfectly understood, except that we know you would be dead above a certain large G-force. (The equivalence of gravitation and acceleration fields is believed to be a fundamental law of physics, not subject to differences of that kind.) Tom decides to assume a default scenario in which biological rates would be unaffected in a strong force field of either origin.

“Prove me wrong”; he accidentally verbalizes, bringing Anatole up short.

Notes:

[1] The figures given here are for “real” Earth time, not special-relativistic, dilative time. No “kill your grandparents” backward time-travel paradox is conceivable under this view where special relativity still holds but cannot produce a permanent “set” in time and where Einstein’s clock hypothesis (the twin paradox) is false.

[2] The local resonant speed of space inside a medium such as glass or water is less than its free-space value because of the increase in the product $\mu\epsilon$ there. The same effect would obtain inside an acceleration field.

As the product $\mu\epsilon$ ($=x$) increases without limit as the gravitation or acceleration field increases, the local resonant speed of light and gravity would then fall towards zero along the curve $y=1/\sqrt{x}$, so that an atomic clock embedded in an infinitely strong field would be expected to stop and remain stopped for as long as it remains in that infinite field.

This resonance phenomenon affects the speed of both light and gravity in the same way. Lightwaves and gravitational waves are seen to be connected in that way because it is known that they both have the same speed, $1/\sqrt{(\mu_0\epsilon_0)}$, in free space.

For a complete mathematical solution of this problem see Ciufolini & Wheeler, *Gravitation and Inertia*, Princeton U.P., 1995, ISBN 0-691-03323-4., section 3.2.2.

Appendix 9

Megalopolis Explained

megalopolis: a heavily populated region centering in a metropolis or embracing several metropolises
...Merriam-Webster's Collegiate dic.

We know that the stars are more densely packed together at the center of the galaxy in a region we'll call *Megalopolis*. If intelligent species have arisen in every n^{th} system throughout the galaxy at about the same time, factors would act to make it likely that the Megalopolitans' starfaring capability is more advanced than ours, and there may already be a buzzing interstellar society in that region. Some of those factors:

(1) the larger number of intelligent species arising in and around the region because of the increased density of stars;

(2) the relative closeness of the neighboring stars there, providing dwellers with a stronger urge to reach out; and

(3) the probability that one of those intelligent species lives on a world having gravity weaker than 1G, making it easier to get into space.

If star travel is as achievable as here indicated, there is some urgency in acting. We do have an advantage in that we know where the Megalopolitans are, whereas we are like a needle in a haystack to them.

Megalopolitan exobiology -

Gravity shapes us all. There is no prevailing sideways force so we are symmetrical left-to-right but not from head to toe.[3] Animals that walk on four legs most of the time are logically asymmetrical from breastbone to backbone, again because of gravity, and that carries over to humanoids. Internal organs fit in as best they can, as internal pressures permit. Progression of food through the body follows the direction of the prevailing gravitational bias, from mouth through stomach and out the

other end. This seems a universal characteristic of land creatures who stand at least part of the time on two hind legs. Gravity is used in other ways by God's creatures; for example, when we lay down for sleeping, that position minimizes the effect of gravity.

Creatures on smaller worlds might be expected to have spindly limbs due to the lesser gravity. Other possible physiological characteristics of the Megalopolitans are subjects for speculation as well, and another example is given now relating to vision.

Humanoid vision -

Because of the 50-50 diurnal illumination pattern on a single-sun planet that rotates "normally" and has a dimmer night sky, it would be expected that other-worlders would have duplex retinas as Humans do (anatomist Max Schultze's 1886 *Duplicity theory*); but if their prevailing "solar" (daytime) and "lunar" (nighttime) illumination spectra differ from ours as they must often do, then their "cone" (daytime) and "rod" (nighttime) spectral retinal responses would also no doubt differ in detail from ours, since - due to evolutionary forces - each would be expected to tend to correlate well with the prevailing ambient illumination spectra just as the nominal photopic (cone) and scotopic (rod) retinal-response peaks in Humans correlate well with the spectra of sunlit and moonlit scenery on Earth, with peaks at respectively, 555 nm, greenish-yellow, and 505 nm, bluish-green.

Do the Megalopolitans see in color? -

Would Megalopolitans be expected to have red-, green- and blue-sensitive cones? Just how such RGB "colored" cones might have evolved in Humans remains a mystery.

*Some have suggested that the rods may be the blue receptors in the trichromatic theory; however it is recognized both by serious supporters and deep-thinking opponents of that theory that they cannot be; and the RGB-evolution problem remains unresolved. **Fortunately we do not need RGB as has been generally believed.***

Thomas Young's 1801 Trichromatic theory, from which the perceived need for RGB cones sprang, is orthogonal to Schultze's widely accepted Duplicity theory. That is, each of the two theories, quite discordantly, appears to exist independently of the other.

Whether or not Human retinas are based on RGB is not at issue here. We are only concerned with how a Megalopolitan's color vision system might have evolved. In this way we bypass any political baggage that might be brought to science by groups all the way from the prestigious *Royal Society* on down.

Rod and cone outputs would give simple nighttime and daytime brightnesses directly. The natural next thing along the evolutionary path would be to compare (subtract) rod and cone outputs in one of the simplest computations that can be performed by a biological neural network consisting of a single neuron having one excitatory input and one inhibitory input.[4] The resulting output is easily shown to be a faithful hue signal.[5] Finally it can be expected (and it has been experimentally found in Humans) that there would be some nonuniformity among cone responses, so that a global comparison of hue signals would result in a saturation signal.

This is full-gamut color vision growing out of Schultze's Duplicity theory; and not at all like Young's Trichromatic theory, inspired though it might have seemed when first proposed.[6]

Helmholtz knew that such a "Megalopolitan" retina would be able to sense the entire color gamut but RGB would not, writing in the mid-19th century, "Every difference of impression made by light...may be regarded as a function of three independent variables... (1) the luminosity [brightness], (2) the hue, and (3) the saturation, [but] to assert that there are simple colors which can be combined [in an RGB system] to produce a visual impression that will be the same as that produced by any other simple or compound light, would not be correct." Helmholtz' insightfulness has survived the test of time.

The Trichromatic theory is implemented in color television cameras of the late 20th and early 21st centuries. It is well known that such camera designs are incapable of sensing the entire color gamut. Saturated yellows, in particular, suffer.

As in Humans, the photoreceptor output signals would be immediately compressed according to the positive half of a bipolar quasi-logarithmic characteristic called by engineers the *AC log*.^[7] The AC log is an odd function. It is linear at the lowest light levels through zero, smoothly becoming logarithmic at higher levels.

The rods would be heavily parallel-connected via excitatory-excitatory neurons in *domains* to boost their nighttime sensitivity (and their daytime sensitivity too); and over a large part of the retina each domain would contain a single, central hue-forming cone receptor. Those things are evolution friendly and in agreement with photomicrographs of the Human retina. The heavy rod-rod interconnections would smooth any nonuniformity among rod responses, and only the average rod response would be felt.^[8] In that way Megalopolitan retinas are able to sense the full gamut not only of hue and saturation, but of brightness as well. TV cameras do not, but Human eyes do. So we leave it to you: Is the Human eye more like the TV camera or the Megalopolitan eye?

Notes continued:

[3] Palm trees on the coast of a desert island may experience a prevailing sideways force due to prevailing on-shore winds. Those trees tend to lean outward, against the wind just as they grow upward against gravity.

[4] In 1947 two radio engineers, Seeley and Avins, found a simple way to perform wavelength/frequency discrimination using only two kinds of receptors or filters, for example rods and nominal cones. Their method, being evolution friendly, is ideal for Megalopolitans' vision. It leads directly to Helmholtz' BHS (brightness, hue, saturation) system, with *hue* being wavelength/ frequency discrimination. See Stuart Wm. Seeley & Jack Avins, "The Ratio Detector," *RCA Review*, Vol.8, June 1947, pp. 201-236.

[5] Homer B. Tilton, "Scotopic Luminosity Function and Color Mixture Data," *J. Opt. Soc. Am.*, Nov '77

[6] According to Leo M. Hurvich, “Palmer preceded Young in this view. He published in 1777.” (*Color Vision*, Sinauer Assoc. Publ., 1981, ISBN 0-87893-337-9, page 129 footnote

[7] Not the “squashing function”, Arctan, promoted by cognitive & linguistic scientist James A. Anderson, which unhappily limits at $\pm\pi/2$ (there is nothing “quasi-logarithmic” or evolution-friendly about Arctan); but a function like $\operatorname{arcsinh}(x)$ which is asymptotic not to a constant limit but to the logarithmic function $\operatorname{Ln}(2x)$.

[8] Homer B. Tilton, “A history of color vision and the modern Helmholtzian brightness-hue-saturation model,” *Atti Della Fondazione Giorgio Ronchi*, ISSN 03912051, Vol. LVI, No. 3, May-June 2001, pp. 487-513.

Chapter 10

An Hypothesis: There Is no Speed Barrier in the Universe

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In this chapter one promotes the hypothesis that: *There is no speed barrier in the universe and one can construct arbitrary speeds*, and one asks if it's possible to have an infinite speed (instantaneous movement).

Introduction

What's new in science (physics)?

According to researchers from the University of Innsbruck in Austria (December 1997): photon is a bit of light, the quantum of electromagnetic radiation (quantum is the smallest amount of energy that a system can gain or lose); polarization refers to the direction and characteristics of the light wave vibration; - if one uses the entanglement phenomenon, in order to transfer the polarization between two photons, then: whatever happens to one is the opposite of what happens to the other; hence, their polarizations are opposite of each other; in quantum mechanics, objects such as subatomic particles do not have specific, fixed characteristics at any given instant in time until they are measured; suppose a certain physical process produces a pair of entangled particles A and B (having opposite or complementary characteristics), which fly off into space in the opposite direction and, when they are billions of miles apart, one measures particle A; because B is the opposite, the act of measuring A instantaneously tells B what to be; therefore those instructions would somehow have to travel between A and B faster than the speed of light; hence, one can extend the Einstein-Podolsky-Rosen paradox and Bell's inequality and assert that the light speed is not a speed barrier in the universe.

Scientific Hypothesis

We even promote the hypothesis that: there is no speed barrier in the universe, which would theoretically be proved by increasing, in the previous example, the distance between particles A and B as much as the universe allows it, and then measuring particle A.

An Open Question now:

If the space is infinite, is the maximum speed infinite?

Controversies

This hypothesis is controversially interpreted by scientists. Some say that it violates the theory of relativity and the principle of causality, others support the ideas that this hypothesis works for particles with no mass or imaginary mass, in non-locality, through tunneling effect, or in other (extra-)dimension(s); the last ones assert that the principle of causality is not violated, i.e. the effect happens second, but because the cause is witnessed via the medium of light it appears to be after the effect – therefore our measurement is relative, not the simultaneity. [Kamla John]

Scott Owens' answer to Hans Gunter in an e-mail from January 22, 2001: It appears that the only things the Smarandache hypothesis can be applied to are entities that do not have real mass or energy or information. The best example I can come up with is the difference between the wavefront velocity of a photon and the phase velocity. It is common for the phase velocity to exceed the wavefront velocity, c , but that does not mean that any real energy is traveling faster than c . So, while it is possible to construct arbitrary speeds from zero in infinite, the superluminal speeds can only apply to purely imaginary entities or components.

Would it be possible to accelerate a photon (or another particle traveling at, say, $0.99c$ and thus to get speed greater than c (where c is the speed of light)?

Future possible research

It would be interesting to study the composition of two velocities v and w in the cases when:

- $v < c$ and $w = c$.
- $v = c$ and $w = c$.
- $v > c$ and $w = c$.
- $v > c$ and $w > c$.
- $v < c$ and $w = \infty$.
- $v = c$ and $w = \infty$.
- $v > c$ and $w = \infty$.
- $v = \infty$ and $w = \infty$.

What happens with the laws of physics in each of these cases?

Notes:

[1] An early version of this paper, based on a 1972 paper, was presented at the Universidad de Blumenau, Brazil, May-June 1993, in a Tour Conference on “Paradoxism in Literature and Science”; and at the University of Kishinev, in a Scientific Conference chaired by Professors Gheorghe Ciocan, Ion Goian, and Vasile Marin, in December 1994.

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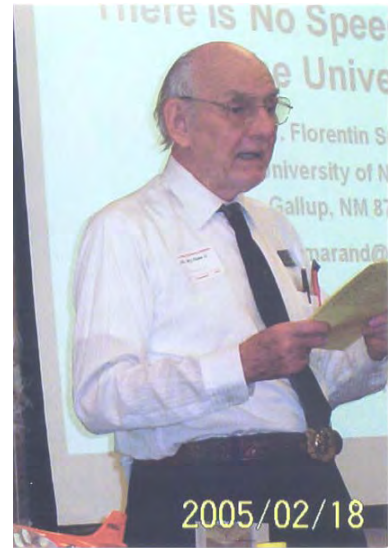
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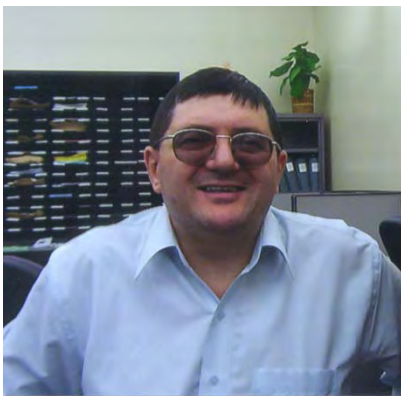
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Homer Benjamin Tilton, born in Montana, served on active duty in the U.S. Air Force during the Korean Conflict 1950-55. After retiring in 1989 from 34 years as an electronics engineer in the aerospace industry, he joined the faculty at Pima Community College where he presently teaches mathematics.



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Florentin Smarandache, born in Romania, escaped to the West in 1988. He received his Ph.D. in Mathematics from the State University of Kishinev in 1997. A prolific writer, he is the author, co-author, and editor of 85 books in mathematics, physics, literature, arts, philosophy. In 2004 he was invited to lecture at NASA Langley Research Center and in 2005 at NATO Advanced Study Institute. He teaches mathematics at the University of New Mexico, U.S.A.

In 1905 Einstein found from relativity that there is an impenetrable light barrier. He reiterated this "finden" in 1916, writing, "...We conclude that in the theory of relativity the velocity c plays the part of a limiting velocity, which can neither be reached nor exceeded by any real body." Poincare and Lorentz did not share Einstein's view. Then in a 1921 lecture and a 1922 book, "Sidelights on Relativity," Einstein wrote (pp. 35-6), "Poincare is right. The idea of the measuring-rod and the idea of the clock coordinated with it in the theory of relativity do not find their exact correspondence in the real world." Thus the light barrier was questioned by the same man who erected it, and the last theoretical obstacle to practical star travel was lifted; but few noticed.

Fifty years later Mendel Sachs wrote about Einstein's "change of mind," again in 1985, 1993, and at other times; but Sachs' writings were scorned. The first author became aware of Sachs' writings in 2004 and the two exchanged views for a time.

This book presents a hard-science case for practical star travel. The first six chapters lay it all out in a logical and factual manner consistent with the theory of relativity. Chapters 7 and 8 outline a "Grand Experiment" designed to probe the light barrier. Chapters 7-9 contain future-fiction accounts of possible scenarios of Humanity's first swaddling steps to the stars. Chapter 10 presents a separate argument questioning the idea of an absolute light barrier.

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